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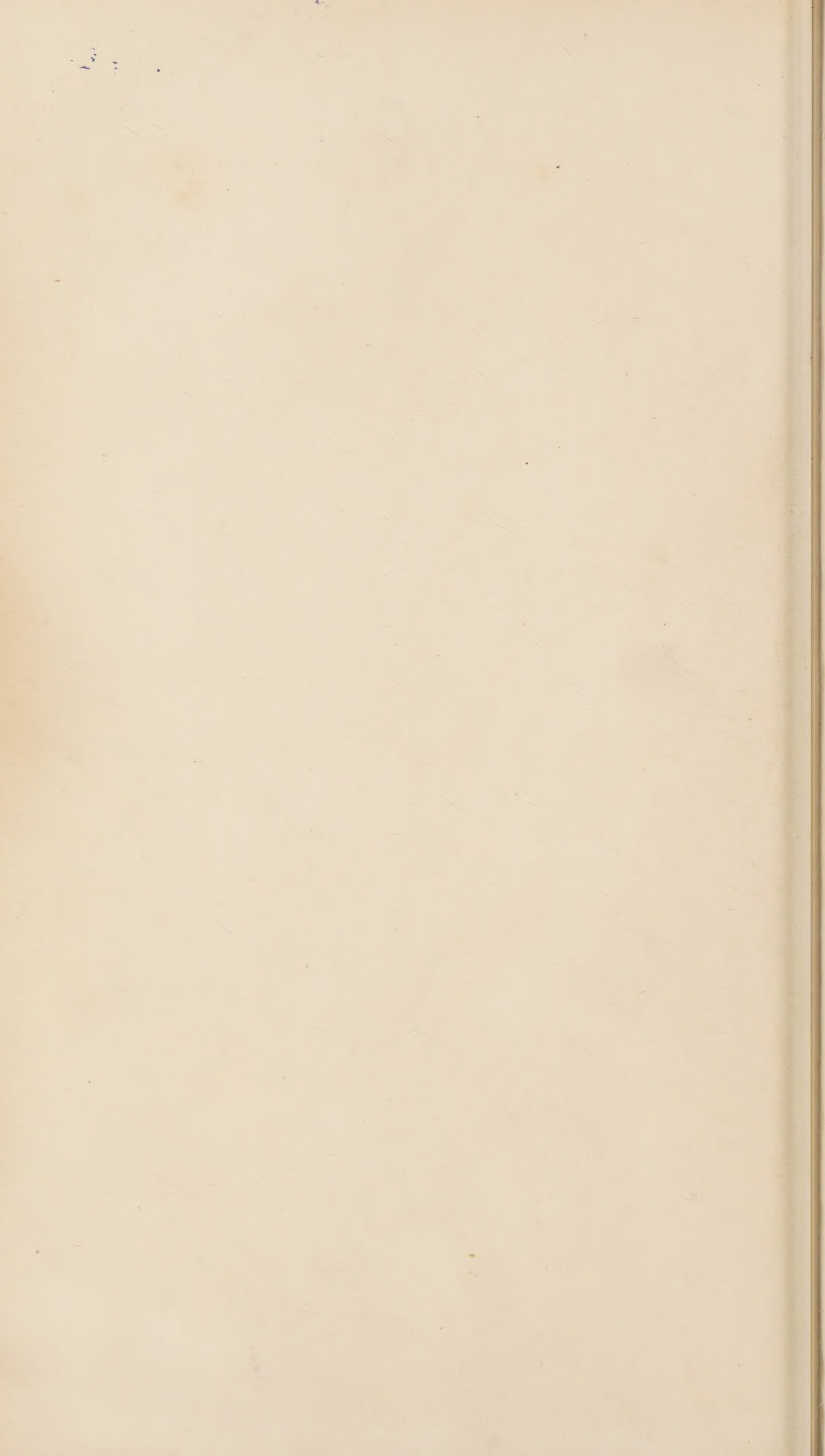
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A  
MANUAL  
OF  
MINERALOGY

COMPREHENDING  
THE MORE RECENT DISCOVERIES  
IN THE  
MINERAL KINGDOM.

BY  
ROBERT ALLAN, Esq.  
F.R.S.E. M.G.S.L., &C.



EDINBURGH

PRINTED FOR ADAM AND CHARLES BLACK  
AND LONGMAN, REES, ORME, BROWN, GREEN & LONGMAN,  
LONDON.

1834.



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PRINTED FOR ADAM AND LONGMAN, NEW, OLD, & DOVER, LONDON.  
LONDON.

1831



TO  
WILLIAM HENRY, M.D.

FELLOW OF THE ROYAL AND GEOLOGICAL SOCIETIES  
OF LONDON,  
VICE-PRESIDENT OF THE  
LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER,  
&c. &c.

THIS VOLUME,  
UNDERTAKEN AT HIS SUGGESTION,

IS RESPECTFULLY INSCRIBED

BY

HIS SINCERE AND OBLIGED

FRIEND

THE AUTHOR.



TO

WILLIAM HEWITT, M.D.

RECTOR OF THE ROYAL AND ECCLESIASTICAL INSTITUTE

OF LONDON

VICE-PRESIDENT OF THE

ASTENARY AND LITERARY SOCIETY OF LONDON

ESQ.

THIS VOLUME

UNDERSTAND AT HIS REQUEST

IS RESPECTFULLY INSCRIBED

BY

HIS SINCERE AND GRATEFUL

FRIEND

THE AUTHOR



## PREFACE.

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IN every science like Mineralogy, to which each consecutive year brings its share of new and valuable contributions, it has been found extremely useful to present occasionally a distinct and comprehensive outline of its actual condition. This service has been rendered, in succession, to the English mineralogist, by Kirwan, Aikin, Jameson, W. Phillips, and by Haidinger, in his enlarged translation of the Treatise on Mineralogy by Frederick Mohs. During an interval of almost nine years, however, which have elapsed since the publication of the last-mentioned work, a great number of new minerals have been discovered, and the boundaries of the science have been considerably enlarged. No work in the English language gives a connected view of these new acquisitions. The descriptions of them are scattered through the periodical scientific publications of Europe and America, and are therefore inaccessible to the great bulk of readers. Even persons who have made considerable progress in mineralogical knowledge, often complain of the want of a treatise, including, within a moderate compass, all that is known of this branch of Natural History, and pointing out the sources from which farther information may be derived,



To fulfil this unambitious purpose the present work has been attempted,—a work which, without pretending to novelty, will bring more distinctly into view the materials already collected, and may thus tend indirectly to the advancement of the science, and to the ultimate construction of a more perfect system.

There are two subjects on which, before proceeding to details, a few remarks are necessary,—the Classification, and the Nomenclature, which have been adopted in the following pages.

The CLASSIFICATION of minerals may be founded either on *external characters*, at once obvious to the senses, or developed by easy and simple experiments ;—or on the comparison of *chemical composition*, as discoverable by careful analysis. Though neither of these courses can by itself lead to a satisfactory arrangement, yet the results of analysis will probably furnish, hereafter, the surest basis of a truly philosophical method ; but this is unfortunately ground which has not been so thoroughly explored as to render its adoption at present advisable. In numerous instances, two different analyses of the same substance are found to lead to different formulæ ; in others, a few general experiments denoting the kind, but not the proportion, of ingredients in a mineral, furnish all the knowledge we possess of its composition ; and, therefore, for a long series of years to come, there will be scope for the labours of the analyst, in supplying sound and ample data for a chemical classification. Meanwhile the “ Natural-Historical” arrangement of Professor Mohs, though confessedly defective, will be found adequate to the object



in view,—that of communicating in the most familiar manner a knowledge of Mineralogy. To that writer's "Orders" Haidinger has added those of Steatite and Terane; both of which, from their comprising chiefly uncrystallized species, are less distinctly characterized than might have been wished. The great fidelity of the descriptions of Professor Mohs, who has given to the system of external characters new extent and precision, will be acknowledged by every one acquainted with Mineralogy; and therefore, in the present work, they are frequently employed without comment, and without repeating this general acknowledgment.

The NOMENCLATURE of Mineralogy has been a fruitful subject of complaint, as offering no facility either to the acquirement or retention of that branch of knowledge. Though arbitrary, capricious, and uncertain from its frequent changes, yet no reform is to be hoped for, until some principles can be agreed upon, which may furnish a nomenclature of minerals derived from permanent characters, not from the accidents which have hitherto led to their designation. Taking names as he found them, the author has refrained from any alterations, convinced that they must necessarily have been short-lived, and have only added to the confusion already existing; and has satisfied himself with giving extensive lists of synonymes, rendered accessible by a copious Index. The value of such a collection of synonymes was abundantly experienced, in the utility of a work published by the author's father in 1814, and again in 1819, entitled "Mineralogical Nomenclature, alphabetically arranged."



For the more simple forms of crystallized Minerals, reference is made to the figures placed at the end of the volume. This very interesting part of the subject, however, has not been pursued beyond what was absolutely necessary in an elementary treatise; and for the more compound forms, and their almost endless modifications, the student is referred to the elaborate and more scientific works of Haüy and Mohs. All signs and formulæ, both crystallographic and chemical, have been studiously avoided; for though important to the advanced mineralogist, by enabling him to economise time, labour, and thought, yet they require long study before they can be made available, and are scarcely suitable to an introductory and popular work. Under the title of “Observations” are noticed the principal localities and modes of occurrence of the different varieties; which the author, having had opportunities of visiting many of the European mining districts, has been enabled to assign with greater accuracy than is generally found in mineralogical books. Under the same head are also described, the principal distinctive characters of the species; the purposes to which any of them are or may be applied; and other circumstances which, it is trusted, will not be considered uninteresting or devoid of value.

Before entering upon the description of mineral species, it is expedient to explain the terms which constitute mineralogical language, and to describe the instruments employed in ascertaining the less obvious characters. The Introduction, which is devoted to these objects, contains brief notices of



Some of the more simple crystalline forms, and their systems of crystallization.

The Specific Gravity.

The degrees of Hardness.

The Colours and their peculiarities.

The degrees of Transparency.

The varieties of Lustre.

The Streak.

The kinds of Cleavage and Fracture.

The Structure as exhibited in double refraction.

Such other External Characters as may be peculiar to certain species or varieties.

The Parasitic Formation of Minerals.

The Chemical Composition, and the Action of Acids.

The Blowpipe, with observations on its use.

Such is the plan followed in the present treatise. In collecting the materials for it, the works of Mohs, Haidinger, Phillips, Jameson, Leonhard, Haüy, Monticelli, Levy, Cleaveland, Brooke, Berzelius, &c., have been carefully consulted and borrowed from largely; and numerous mineralogical notices have been obtained from the different scientific journals, from the Transactions of the Royal Societies of London and Edinburgh, the Wernerian, and other learned associations, both domestic and foreign.

Prepared so far under the superintendence of a late lamented parent, whose skill in discriminating the objects of this science, and zeal in its pursuit, had enabled him to form a collection of highly characteristic minerals, with which the descriptions hereafter given have been diligently collated, it is hoped the present work is free from im-



portant errors. Business avocations must, however, plead the author's apology for such inaccuracies as may have escaped him. In conclusion, he begs to acknowledge the valuable assistance afforded him by his friends Dr Henry, Dr Traill, and the Rev. Mr Macvicar, to the last of whom he is indebted for the important notice on the structure of minerals as exhibited in their double refraction.

*LAURISTON CASTLE,*

*July 1834.*



## INTRODUCTION.

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MINERALOGY is that science which comprehends what may be termed the Natural History of Minerals, describing their forms, varieties, characters, and component parts, and noticing the circumstances and positions in which they occur, and the properties and uses to which they may be applied. Geology comprises the study of the mass of the materials of our globe; mineralogy of the individual portions or substances forming that mass. To the geologist, therefore, mineralogy must ever be a science of the deepest importance, as, without an accurate knowledge of the minerals composing the different strata, he cannot ascertain the composition of the earth's surface; and without this guide he may be induced to draw the most erroneous conclusions. Mineralogy, as a science, is also tributary to the arts. To the miner, the smelter, and the chemist, it is of daily utility; and it supplies materials to the dyer, the bleacher, the agriculturist, the mason, the jeweller, &c., to be worked up into a variety of forms for use or ornament.

The mineralogist then must not content himself with a mere general knowledge of minerals, or be satisfied with his capability of distinguishing rare and curious species. He must make himself acquainted with their various properties, and the uses to which they may be applied; with the circumstances attending their occurrence in nature; the countries in which they are found; their comparative scarcity or abundance; and their characters both physical and chemical.

To facilitate the attainment of such knowledge, the different species must be considered under distinct orders or genera, each of which will include a cluster or group of such as, on an exa-



mination of their physical properties, are found to possess the strongest analogy to one another. The union under a common head of small assemblages of species, whose resemblances in some instances are sufficiently obvious, tends materially to aid research; for when the species to which a mineral under examination belongs, has been ascertained, it is easy, by comparing its characters with the different species composing the order, to determine that with which it must be classed. For this purpose its form, hardness, and specific gravity, are in the first place determined; then its colour, lustre, streak, and cleavage, which, if not sufficiently characteristic of the species, are followed up by such other external, as well as internal properties, as will determine—if it be not a new mineral—the particular species to which it belongs.

A certain degree of skill is requisite in investigating, and, in many instances, in applying, these characters; but a close attention to the minutest details, aided if possible by a little tuition, will, in the course of a short practice, render the task extremely easy.

There are certain minerals which may at once be detected by recourse to experiments; that is to say, there exist a few, possessing some one character which decides with precision what the mineral must necessarily be, because that property belongs to no other. Comparatively few substances, however, can be identified by so simple a process; and we must then resort to other characters, by a comparison of a number of which we may generally attain the desired object.

The characters of minerals may be said to be of two kinds,—external or physical, and internal or chemical.

The external characters are numerous, and require to be accurately defined, in order that the same language may always convey the same definite idea. They naturally take the precedence, as being the most easily ascertained; and we shall therefore consider them in that order in which they can with most convenience be distinguished.



## OF THE MORE SIMPLE CRYSTALLINE FORMS.

“ In mineralogy,” says Mohs, “ the term *crystal*\* is applied to a body which consists of continuous and homogeneous matter, and occupies from its origin a regularly limited space ; and the object of crystallography is to ascertain that regularly limited space, or the *form of the crystals*, not the matter of which that space is composed.” The regularly limited space, occupied by a crystal, is called a *form of crystallization* ; the limits or planes of this space are termed *faces of crystallization* ; and the intersection of these faces with each other are their *edges*. A form contained under equal and similar faces is termed a *simple form* ; that which is contained under faces not equal and similar is a *compound form* or combination. The plane which intersects a simple form is called a *section*, and that which divides the form into two equal parts, without dissecting an edge, is its *principal section*. A *plane angle* is that produced by the meeting of two faces ; a *solid angle* is a point formed by the meeting of three or more faces. Instead of the edge or the solid angle, we sometimes find a plane ; in which case the edge or solid angle is said to be *replaced* or *truncated* ; and when the edges of a crystal are replaced by two planes, separated only by an edge, they are described as *bevelled*. The *axis* is an imaginary line passing through the centres of two parallel sections, and at same time through the centre of the solid. A form is said to be in *upright position* when one of its principal axes is vertical ; and two or more forms are considered to be in *parallel position* if the axes of the one are parallel to the homologous axes of the other.

The *regularity* of simple forms is their greater or lesser agreement with the regular solids of geometry, to which, how-

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\* The Greek *κρυσταλλος*, whence this word is derived, originally meant *Ice*, and was transferred by ancient mineralogists to rock-crystal, which, from its colourless transparency, they supposed to be petrified ice ; but the term is now applied to opake and variously coloured individuals, as well as to those which are clear and devoid of colour.



ever, we must reduce the crystals under examination, as the irregularities so frequently occurring in crystals cannot be taken into consideration.

The *Rhombohedron*, fig. 1, is a form contained under six equal and similar rhombs or rhomboidal planes, and is of frequent occurrence in calcareous spar.

*Pyramids* are such solids as are contained under triangular faces; and according as they present eight, twelve, or sixteen faces, they yield the four, six, or eight-sided pyramid. These triangular faces are either isosceles or scalene, and the pyramids receive their denominations accordingly. Thus we have the *isosceles four-sided pyramid*, fig. 2, contained under eight isosceles triangles; the *scalene four-sided pyramid*, fig. 3, contained under eight scalene triangles; the *isosceles* and *scalene six-sided pyramid*, figs. 4 and 5, contained in the same way under twelve, either isosceles or scalene triangles; and the *scalene eight-sided pyramid*, fig. 6, contained under sixteen scalene triangles. All these pyramids occur in nature.—Tungstate of lime is found in four-sided pyramids; as is anatase, but more acute; and tin in macles, very obtuse. Isosceles six-sided pyramids are common in quartz; scalene six-sided pyramids in the calc spar from Derbyshire; and eight-sided ones in zircon, tin, &c. though more rarely. Considered separately, a pyramid is supposed to have a base, which is the case with the tetrahedron; but in respect of most other forms this base is only imaginary, as in the octahedron, which may with propriety be termed a four-sided pyramid.

The *Tetrahedron*, fig. 7, is formed of four solid angles, and is contained under four equilateral triangles, the faces of which incline to each other at an angle of  $70^\circ$ . It presents itself in the grey copper from Cornwall.

The *Hexahedron* or Cube, fig. 8, is contained under six squares, all the angles of which are consequently  $= 90^\circ$ .

The *Octahedron*, fig. 9, is contained under eight equilateral triangles; its plane angles being  $= 60^\circ$ , and its edges or angles of incidence  $= 109^\circ 28' 16''$ .

The hexahedron has six faces and eight solid angles, the



octahedron eight faces and six solid angles. The former occurs frequently in iron pyrites and fluor; the latter in magnetic iron ore, galena, and red copper.

*Dodecahedrons* are contained under twelve equal and similar faces, the figure of which determines the kind of dodecahedron. Thus a dodecahedron whose faces are triangles is termed a *trigonal* dodecahedron, fig. 10.; one whose faces are tetragons, a *tetragonal-dodecahedron*, figs. 11 and 12; and one whose faces are pentagons, a *pentagonal-dodecahedron*, fig. 13. The common rhombic dodecahedron, fig. 11, which is limited by twelve similar rhombic faces, whose plane angles are equal to  $109^{\circ} 28' 16''$ , and  $70^{\circ} 32' 44''$ , comes under the denomination of tetragonal-dodecahedrons. The faces in this incline to each other at an angle of  $120^{\circ}$ .

*Icositetrahedrons* are solids possessing twenty-four equal and similar faces, the figure of which, as with the dodecahedron, determines the kind of icositetrahedron, whether trigonal, figs. 14, 17, and 19; tetragonal, figs. 15 and 18; or pentagonal, fig. 16.

*Tetraconta-octahedrons* are contained under forty-eight scalene triangles, as represented in fig. 20. This is a form peculiar to the diamond.

*Prisms* are those solids whose lateral edges are parallel, and whose terminal planes are also parallel. Those prisms which stand perpendicularly when resting on their base are called *right* prisms; those which incline from the perpendicular are termed *oblique* prisms. Fig. 21 represents a right four-sided prism, and fig. 22 a right six-sided prism,—both forms of frequent occurrence in nature; and fig. 23 an oblique four-sided prism,—which is met with in laumonite. When the lateral faces of the prism are extremely short, a flat table-shaped solid is obtained, which, according to the number of its sides, is characterized as a four, six, eight, or twelve-sided table. This last is represented by fig. 24.

Now it is a well-known fact, that certain of these crystalline forms are peculiar to certain mineral species, whilst other forms of crystallization are never found in the same substances. Thus



gold occurs in cubes, but never in rhombohedrons; calc-spar in rhombohedrons, but never in cubes. Experience proves quite as generally, that varieties of the same species may assume several different forms of crystallization. Calcareous spar, for instance, takes the form of a six-sided pyramid as frequently as it does that of the rhombohedron, galena that of the octahedron almost as commonly as the form of the cube. The conjunction of two or more simple forms on the same crystal is likewise an occurrence of the most common description. It is then termed a *compound form*, or a *combination*; and it is the endless variety of these combinations which renders crystallography such an interesting and amusing study. Such combinations, it is worthy of remark, always occur in nature symmetrical; and although certain apparent exceptions may present themselves to this symmetry, they are merely accidental, arising from a disproportionate enlargement of certain faces of crystallization, or depending upon the contact into which one individual has come with another. These are therefore deviations from that regularity which has been supposed to take place in the preceding consideration of forms.

There is one remarkable fact, however, to which the attention of mineralogists was called by Romé de l'Isle, that notwithstanding the irregular and changeable enlargements of certain faces, and the indistinct formation of the edges between these faces, that the angle at which they meet always remains constant. This peculiarity affords one of the most distinctive characters which minerals possess; one by which the mineralogist is frequently led immediately to the determination of a species; and which, therefore, it is evidently of extreme importance he should ascertain with precision.

The instrument of most general use for ascertaining the angles of crystals is that termed the *Goniometer*, or measurer of angles. Of this there are two kinds; the common or hand goniometer invented by Carangeau, and the reflective goniometer proposed by Dr Wollaston. The former serves to denote with sufficient accuracy the angles of such individuals as are of a large size. But small crystals being less subject to irregular-



ities than large ones, the reflective goniometer, by which alone their angles can be ascertained, becomes to the mineralogist an instrument of indispensable utility. For the reflective goniometer the surface may be very small, provided it be perfect and brilliant; the hundredth part of an inch in length and breadth will suffice, if, as indeed is absolutely necessary, the instrument be handled with skill and precision.

A frequent occurrence in crystallography is that of *macles or twin-crystals*, in which certain parts of one individual are always in exactly reversed situations, in respect to homologous parts, of the other. This occasions, under certain circumstances, the production of angles greater than  $180^\circ$ , which are not to be met with in the faces of simple individuals, as considered above. These angles are said to be *re-entering*, and they are commonly, though not always, characteristic of a twin-crystal. In many instances the most remarkable forms are thus produced, particularly in the species tin, silver, gold, copper-pyrites, calc-spar, felspar, diamond, &c. (For a particular description and representation of some of these, the reader is referred to Haidinger's excellent papers on the Regular Composition of Crystallized Bodies, in the early volumes of Brewster's Journal.) A twin-crystal always supposes the existence of at least two distinct individuals; Haüy's term *hemitrope*, on the contrary, indicates the presence of one only—the half of which, by a seeming freak of nature, has been turned, during crystallization, in an opposite direction, or has been caused to revolve  $180^\circ$ , while the other half remained at rest. It is of frequent occurrence in augite, felspar, &c.

Imbedded or perfectly symmetrical crystals are rare; more frequently they occur attached, and then of course their geometrical form is imperfect. Most quartz crystals, for instance, present the form of six-sided prisms, which are terminated at one extremity by six-sided pyramids, while at the other there are no faces, being thereby connected with the matrix. When this irregularity is carried to excess, as in coarse-grained limestone, one individual is limited on every side by others, and they all by that means interfere with the regular structure of each



other. In this case the faces of each individual are not such as nature intended they should be ; but they present an irregular surface, to which the name of compound faces is given.

There is another very interesting property in the crystallization of minerals, which is of essential importance in the study of the science. I allude to the identity of simple forms, from which every crystal of the same species, however complicated it may appear, is capable of being derived ; a peculiarity which the internal structure of minerals, as exhibited by their optical properties, tends most strikingly to confirm. These simple forms amount only to four :

1. The scalene four-sided pyramid ;
2. The isosceles four-sided pyramid ;
3. The rhombohedron ; and
4. The cube.\*

And, from the extremely simple systems of crystallization derived from them, they are now universally received among mineralogists.

*Prismatic System.*—From the scalene four-sided pyramid, fig. 3, are derived all the scalene four-sided pyramids, and the prisms ; from two of which, again, the right rhomboidal prism, and the oblique rhomboidal prism, are derived the subordinate series of the hemi-prismatic and tetarto-prismatic systems.

*Pyramidal System.*—From the isosceles four-sided pyramid, fig. 2, are derived all the isosceles four-sided pyramids, and the scalene eight-sided pyramids, figs. 6, 7.

*Rhombohedral System.*—From the rhombohedron, fig. 1, are derived all the rhombs, the scalene six-sided pyramids, fig. 5, and the isosceles six-sided pyramids, fig. 4.

*Tessular System.*—From the cube are derived the octahedron, fig. 9 ; the dodecahedron, fig. 11 ; the octahedral trigonal-icositetrahedron, fig. 14 ; the digrammic tetragonal icositetrahedron,

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\* These Mohs denominates *fundamental* forms ; but this, being a term which is frequently applied to the primary forms of minerals as obtained by cleavage, is, for the sake of perspicuity, better omitted.



fig. 15; the hexahedral trigonal icositetrahedron, fig. 19; and the tetraconta-octahedron, fig. 20. The tetrahedron, fig. 7; the hexahedral pentagonal dodecahedron, fig. 13; the digrammic tetragonal dodecahedron, fig. 12; the trigonal dodecahedron, fig. 10; the tetrahedral trigonal icositetrahedron, fig. 17; the trigrammic tetragonal icositetrahedron, fig. 18; and the pentagonal icositetrahedron, fig. 16; are all solids belonging to the tessular system.

For the manner in which these forms are derived, the student of crystallography is again referred to the elaborate work of Mohs, where he will find the most ample instructions as to his mode of procedure. At present it is enough to mention the fact, and to request it may be kept in view, that all the forms which any mineral assumes must belong to the same system of crystallization. For the sake of aiding in the examination, as well of the crystalline form, as in the optical structure of the mineral, the description of the different species, so far as they have been accurately ascertained, is in the following pages commenced by mentioning the *system* to which each species appertains. These systems of crystallization of course refer only either to crystallized minerals, or to such as possess a crystalline structure; and where individuals are not distinct externally, we must have recourse to their optical properties, as shall shortly be noticed under that head.

It is often extremely difficult, when a complicated crystalline form is placed in one's hands, to determine to what system it belongs; and it is only by an intimate acquaintance with the more simple forms of the same system that this object can be attained. Hence the vast importance to young mineralogists of an easy access to large and correctly arranged collections of minerals, especially to such as contain well-chosen suites of crystals. On the derivation of crystalline forms much instruction may be obtained from Brooke's Familiar Introduction to Crystallography, which presents numerous very excellent woodcuts explanatory of different modifications.



## SPECIFIC GRAVITY.

Two masses exactly corresponding in size, but consisting of different substances, are found in most cases to disagree in weight. If the weight of one of these be considered as unity, the proportional weight of the other is termed its specific gravity. For example, suppose a cube of water to weigh exactly a pound, a similar sized cube of calc-spar will weigh two pounds and nearly seven tenths of a pound, a sum which is represented in decimals as equal to 2·7.

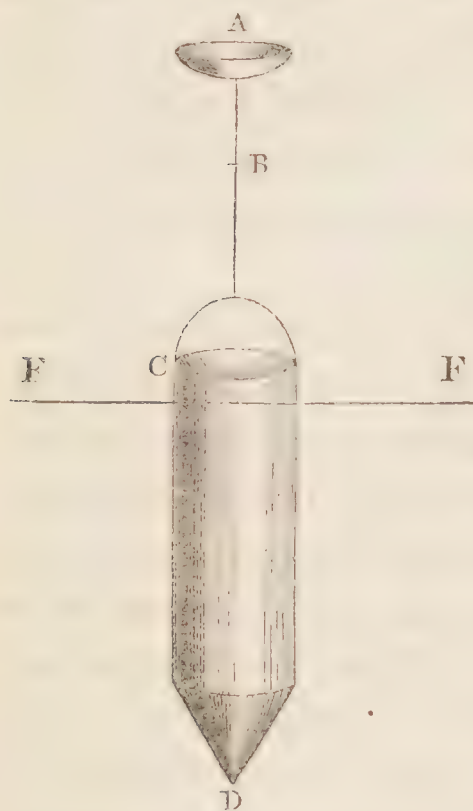
This is one of those physical properties which are extremely useful in acquiring a knowledge of the inorganic productions of nature, as it can not only be easily ascertained to a considerable degree of accuracy, but is constant, or at least ranges within very narrow limits, in minerals of the same species.

The instruments used for ascertaining the specific gravity of solid bodies, are the hydrostatic balance and the areometer. The former allows of very high degrees of accuracy, and is most conveniently used in the following manner:—One of the scales of a very fine balance being elevated considerably above the other, a small hook is attached to its lower surface, from which a watch-glass is suspended by means of a hair or a fine fibre of silk. The mineral is then placed in the watch-glass, and along with it immersed in water. Thus the difference indicated in the weight of the mass, before and after its immersion in the fluid, amounts to the weight of the quantity of water displaced by the bulk. When an experiment is to be performed, this glass is immersed in water, and the weight of the mineral lying in the elevated scale first ascertained. For instance, a piece of metal is found to weigh in the elevated scale 2·645 grains; but when put into the watch glass and immersed in water, its weight amounts only to 0·295 grains. Then, as 0·295 is to 2·645, so is unity to the specific gravity of the metal, which in this case will be found to amount to 8·966.

The delicacy of the hydrostatic balance occasions it to be affected by the slightest current of air, and it therefore requires.



when used, to be inclosed in a glass-case. For this reason, in performing common experiments, and in most cases for obtaining the required results with quite sufficient accuracy, the areometer will be found preferable. This instrument has also the



advantages of cheapness and portability. Its form resembles the accompanying figure. The body consists of a hollow cylinder or tube, the lower portion of which terminates in a point. A certain quantity of lead is melted into the bottom of this at D, so as to give it, when placed in water, an upright position, and admit at same time of a portion of the cylinder rising above the surface, as may be supposed to the line F. Weights are then placed in the cup A, until the whole instrument is depressed in the water to the point B, marked upon the wire-index which supports

the cup. This gives the normal or standard weight. The mineral under examination is then placed in the cup A, and so much of the weight at same time removed from it, as to raise the whole again to the index-point B marked on the wire. By this means the actual weight of the specimen is obtained; but when it is removed from the cup A, and placed on the top of the cylinder, which is a little hollowed at C, the instrument will be found to rise considerably in the water, and a certain weight will then be requisite to depress it to the above-mentioned point B. This last weight then is required to counterbalance the loss sustained by the mineral in water, and is equivalent to the weight of the volume of water displaced by the mineral. The *second* weight subtracted from the *first* or normal weight, leaves the absolute weight of the mineral; the *second* weight deducted from the *third* leaves the weight of an equal volume of water; and from these results, as on the former occasion, the specific gravity of the mineral may be reckoned. The normal



weight, for instance, is twenty grains, that is, it requires 20·000 to depress the instrument to the point B. Suppose the same piece of metal as in the former experiment to be used: it is placed in the cup A along with 17·355 grains, in order to bring the instrument to the same depth. When removed from the cup A to that at C, 17·650 grains are found requisite to produce the same effect. And now, to find the specific gravity, divide 20·000 — 17·355, or 2·645, by 17·650 — 17·355, or 0·295, from which, as in the foregoing case, the specific gravity of the mineral will be found to amount to 8·966.

A considerable degree of attention is necessary both in selecting the specimens and in performing the operation of weighing. The minerals intended for examination require to be perfectly pure; and, previous to commencing, the greatest care must be taken to remove whatever foreign matter may adhere to the specimen. All the vacuities or empty spaces are to be carefully opened, or the mineral broken down, not into powder, but into fragments; and distilled water must be used, of a temperature not differing much from 60° Fahr. When the mineral, during the process, is supposed to have absorbed water, the weight of what is imbibed may be ascertained by again weighing the mineral in air, and adding the amount to the first term of the proportion, or, what will generally suffice, it may be varnished before being subjected to such examination.

### HARDNESS.

Hardness is a very useful property in determining minerals, and we are indebted to Professor Mohs for a scale easily formed, and at same time distinct and accurate. The means of applying it also are within the reach of every mineralogist. It consists of

1. Talc, of a white or greenish colour.
2. Rock salt, a pure cleavable variety; or gypsum uncrystallized, and only semi-translucent.
3. Calcareous spar, any cleavable variety.



4. Fluor spar, presenting good cleavage.
5. Apatite, the asparagus stone from Salzburg.
6. Adularia, any perfectly cleavable variety.
7. Rock crystal, limpid and transparent.
8. Topaz, any simple variety.
9. Corundum stone from Bengal, which affords smooth surfaces when fractured.
10. The diamond.

In employing this scale we endeavour to find the degree of hardness of a given mineral by trying which number of the series is scratched by it ; or, still better, by passing with the least possible force the specimens under comparison, over a very fine file. Every person will observe a marked difference on comparatively trying in this way any two consecutive numbers of the above scale, and by a little experience he will soon acquire the manual skill necessary for nice discrimination.

From the resistance these bodies afford to the file, from the noise occasioned by their passing over it, and from the quantity of powder left on its surface, their mutual relations in respect to hardness are deducible with great correctness. When, after repeated trials, we are satisfied which member of the series our mineral is most closely allied to, we say its hardness (suppose it to be calc-spar) is equal to 3, and write after it  $H. = 3.0$ . If the mineral do not exactly correspond with any member of the series, but is found to be between two of them, we say  $H. = 3.5$ , or  $3.75$  if it approximate to the higher number. Care, however, must be taken to employ specimens of each which nearly agree in form and size, and correspond as much as possible in the shape of their angles. They must likewise possess perfect purity, as the degrees of hardness can no more be correctly ascertained than the specific gravity, if impure substances are made use of. The file required for this purpose should be cut fine, and if possible of the hardest steel. The latter property, however, is of less moment, as it is not the hardness of the tool with which we are to compare that of the mineral, but the relative degrees of hardness of minerals, which are to be ascertained through the medium of the file.



## COLOUR.

Although one of the most striking, this is by no means the most characteristic property of minerals. It requires, however, more attention than most mineralogists are inclined to bestow upon it; for, being obvious at first sight, and therefore easily determined under whatever circumstances it may be found, it frequently enables the mineralogist to dispense with farther examination, and at once to decide on the species to which the mineral under examination belongs.

This property should be considered under two different aspects, according to the nature of the substances by which it is produced. Many minerals owe their colour to an accidental admixture of metallic oxides, particularly those of iron, chrome, and manganese, which, according to their proportion or their different degrees of oxidation, afford a great variety of different tints. This is the case in most earthy minerals, and among them it is therefore evident that little reliance can be placed on colour as a characteristic. Among the metals, however, where it depends on the nature of the mineral, and is produced by light reflected from homogeneous parts, colour becomes a character of considerable value.

The metallic colours are,

1. Copper-red,—the colour of native copper, and titanium.
2. Bronze-yellow,—the colour of several metallic alloys, as bronze; also that of iron- and cockscomb-pyrites.
3. Brass-yellow,—peculiar to copper-pyrites.
4. Gold-yellow,—the colour of pure gold;—at times somewhat paler, and then approaching to silver-white.
5. Silver-white,—the colour of native silver.
6. Tin-white,—the colour of pure tin unmixed with lead; also that of antimony.
7. Lead-grey, of which there are three hues: whitish lead-grey, as presented in compact varieties of galena; pure lead-grey, as in common varieties of the same species; and blackish lead-grey, as in vitreous silver ore.

As already remarked, these metallic colours are nearly iden-



tical in all varieties of the same species. Among the non-metallic colours, however, the case is different ; and although, for the sake of explaining what may be afterwards stated in describing the species, the eight principal colours and their several varieties, as proposed by Werner, are here enumerated, it must be premised that a scale of colour scarcely admits of verbal description ; for such information we must apply to our collections, and study the series as it appears in nature.

The following are the non-metallic colours :

*White.*

1. Snow-white—the purest white colour, nearly that of new-fallen snow, as in Carrara marble. 2. Reddish-white—white inclining somewhat to red, as in some varieties of pearl-spar and calc-spar. 3. Yellowish-white—white inclining to yellow, as in several varieties of calc-spar and opal. 4. Greyish-white—white inclining to grey, common in granular limestone and in quartz. 5. Greenish-white—white somewhat inclining to green ; amianthus and common talc. 6. Milk-white—white with a bluish tinge, the colour of skimmed milk ; as in opal.

*Grey.*

1. Bluish-grey—grey inclining to a dirty-blue ; occasionally in hornstone and calc-spar. 2. Pearl-grey—grey mixed with red and blue ; sometimes distinct in muriate of silver. 3. Smoke-grey—grey mixed with brown, the colour of thick smoke ; in certain dark varieties of flint. 4. Greenish-grey—grey mixed with green ; cat's-eye and several of the micas. 5. Yellowish-grey—grey mixed with yellow ; not uncommon in compact varieties of limestone and flint. 6. Ash-grey—the purest grey colour, a mixture of white and black ; leucite and zoisite.

*Black.*

1. Greyish-black—black mixed with grey, the colour of basalt ; Lydian stone. 2. Velvet-black—the purest black colour ; obsidian and blind coal. 3. Greenish-black—black mixed with green ; common in several species of augite. 4. Brownish-black—black mixed with brown ; as in coal, and certain varieties of mica. 5. Bluish-black—black mixed with blue, a rare colour ; as in the reniform black cobalt-ochre from Saalfeld in Thuringia.

*Blue.*

1. Blackish-blue—blue mixed with black ; dark-coloured blue carbonate of copper. 2. Azure-blue—bright blue with a slight tinge of red ; lapis-lazuli. 3. Violet-blue—blue mixed with red ; in amethyst, and frequently in fluor spar. 4. Lavender-blue—blue with a tinge of red and a great deal of grey ; porcelain jasper. 5. Plum-blue—peculiar to a few varieties of spinel and fluor. 6. Berlin-blue—the purest blue colour ; sapphire, kyanite, and sometimes in rock-salt. 7. Smalt-blue—a pale blue colour resembling smalt ; some varieties of gypsum. 8. Indigo-blue—the darkest blue colour, similar to that of coarse indigo ; phosphate of iron and certain tourmalines. 9. Duck-blue—blue with much green and a little black, occasionally in spinel and tourmaline. 10. Sky-blue—pale blue with a little green, resembling the colour of the clear sky ; lenticular arseniate of copper.

*Green.*

1. Verdigris-green—green much inclining to blue ; Amazon stone. 2. Celadine-green—green mixed with blue and grey ; green earth. 3. Mountain-green—green with a large proportion of blue, as in aqua-marine. 4. Leek-green—green with a little brown ; prase. 5. Emerald-green—the purest green colour ; distinct in emerald. 6. Apple-green—light green with a trace of yellow ; chrysoprase. 7. Grass-green—the fresh colour of grass ; uranite and green malachite. 8. Pistachio-green—green with a little yellow ; chrysolite, and sometimes in epidote. 9. Asparagus-green—pale green with a large proportion of yellow ; chrysoberyl and asparagus-stone. 10. Blackish-green—green with black ; as in many varieties of augite. 11. Olive-green—pale green verging on brown ; olivine and arseniate of iron. 12. Oil-green—a lighter green, inclining to yellow, the colour of olive oil ; in some varieties of blende. 13. Siskin-green—a very light green colour, approaching to yellow, as in the uranite of Autun.

*Yellow.*

1. Sulphur-yellow—the colour of pure sulphur. 2. Straw-yellow—light yellow with a little grey, nearly the colour of straw ; pycnite. 3. Wax-yellow—yellow with a little brown,



the colour of yellow wax ; molybdate of lead, and certain opals. 4. Honey-yellow—yellow with a little red and brown ; mel-lite, and some calc- and fluor-spars. 5. Lemon-yellow—the purest yellow colour ; yellow orpiment and uran-ochre. 6. Ochre-yellow ; this is a very improper denomination, but is meant to denote yellow with brown, as in some varieties of quartz mixed with oxide of iron. 7. Wine-yellow—a pale yellow with a little red ; Saxon topaz. 8. Cream-yellow—pale yellow with a tinge of brown, as in some varieties of bole. 9. Orange-yellow—yellow much inclining to red, the colour of ripe oranges ; as in certain varieties of molybdate of lead.

#### *Red.*

1. Aurora-red—red with a tinge of yellow ; red orpiment. 2. Hyacinth-red—red with yellow and a little brown ; garnet and red zircon. 3. Brick-red—red with yellow and brown, the colour of new bricks ; red heulandite and stilbite. 4. Scarlet-red—the brightest red colour ; cinnabar. 5. Blood-red—red with a tinge of yellow and black ; pyrope. 6. Flesh-red—a pale red colour, with grey and a little yellow ; in some varieties of heavy spar. 7. Carmine-red—the colour of carmine, as in rubellite. 8. Cochineal-red—red with a little blue ; red silver ore, and certain garnets. 9. Rose-red—a pale red colour mixed with grey ; rose quartz and carbonate of manganese. 10. Crimson-red—a particularly fine colour, which is met with in cobalt-bloom, and the bright-coloured varieties of ruby. 11. Peach-blossom-red—red with much grey ; lepidolite. 12. Columbine-red—red with blue and much black ; garnet. 13. Cherry-red—a dark red mixed with blue and a little brown ; red antimony. 14. Brownish-red—the colour of reddle, a well-known ferruginous clay used in drawing ; red hematite.

#### *Brown.*

1. Reddish-brown—brown mixed with much red ; zircon. 2. Clove-brown—brown with red and a little blue ; distinct in axinite. 3. Hair-brown—brown with a little yellow and grey ; brown iron ore. 4. Chestnut-brown—the purest brown colour ; Egyptian jasper. 5. Yellowish-brown—brown with a great deal of yellow ; iron flint. 6. Pinchbeck-brown—yellowish-brown

with a metallic pearly lustre ; certain micas. 7. Wood brown—brown with yellow and grey, like old rotten wood. 8. Liver-brown—brown with grey and a little green ; frequently in jasper. 9. Blackish-brown—brown with a great deal of black ; bitumen and brown coal.

This scale will be found to comprehend almost every tint that is met with among minerals. Any colour differing from one of these fixed points is considered as representing that colour, only *inclining* or *passing* into another. They may likewise vary in intensity, though belonging to the same variety, in which case such differences are indicated by the expressions *pale*, *light*, *deep*, *dark* ; and thus in many species they pass so insensibly into each other, as to form an uninterrupted succession or series of colours. Crystals of simple forms usually present only one colour, although there are many exceptions to this rule. Compound minerals, on the contrary, are often variegated, as exhibited in the very beautiful varieties of agate and calcedony.

It may easily be inferred from the above observations that colour is by no means to be depended upon as a mineralogical character ; first, because the same substance is frequently referred to as examples of very different colours ; and, secondly, because the detection of colour depends upon the state in which the mass presents itself. No expression is more common than “black as jet ;” but jet, if cut thin enough, will be found to possess a brilliant orange-brown colour. The pleonaste of Ceylon, and the tourmaline of Hoboken, are to all appearance equally black as jet ; but when cut thin, the one presents a dark-blue, and the other an indigo-blue colour ; besides, the same mineral sometimes occurs under all the colours of the rainbow, as may be observed in corundum, fluor spar, &c. Another fallacy arises from the property of certain varieties changing their colour on exposure to light ; thus chrysoprase, rose quartz, and red cobalt, become paler ; while corneous silver and several of the metals change to brown and black.

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There are several peculiarities in the occurrence of colours which require to be mentioned in this place.

The *play of colours* is produced when the mineral, in certain directions, reflects as it were coloured points of great intensity, which change with the position of the mineral, or with the direction of the rays of light. Of this property the diamond when cut, and precious opal both cut and in its natural state, afford examples; in the first it depends upon the reflexion of refracted light, occasioned by artificial facets; in the last, upon accidental cracks and fissures with which the mineral is interspersed. This phenomenon is only to be observed in sunshine or in strong light.

The *change of colours* consists in the reflection of bright hues of colour, in certain directions, depending upon the structure of the mineral, as is evinced in a remarkable degree by Labrador felspar.

*Opalescence* is a kind of reflected milky light, which certain minerals exhibit, either if cut *en cabochon*, or upon plain faces both natural and artificial: in cat's-eye it depends on fibrous composition; in adularia and corundum, on crystalline structure. This appears particularly in crystals of sapphire and ruby cut *en cabochon*, perpendicular to the axis, which produces the well-known star stones; and in adularia, when cut parallel to the acute edge of the prism.

*Iridescence* is the production of prismatic colours occasioned by the refraction of light from internal surfaces. It presupposes fissures or separations in the interior of the mineral, which may depend on structure, as in Labrador felspar; on composition, as in rainbow calcedony; or on accident, as in rock-crystal.

*External Iridescence*, generally denominated *Tarnish*, depends altogether on other circumstances, being sometimes apparently derived from the action of acidiferous fumes, but more frequently from partial decomposition.

Another remarkable property of certain minerals is their exhibition of different colours when examined by transmitted light in different determined directions, which demonstrates its

intimate connection with their forms and structure. This property is called *Dicröism*, and is very distinct in iolite, tourmaline, and mica. The first of these minerals is blue in the direction of the axis, yellowish-grey perpendicular to it. Several varieties of the second are nearly opake in the direction of the axis, while they exhibit different degrees of transparency, and different green, brown, and blue colours in the direction perpendicular to it. Mica is frequently green in the one direction, brown in the other, &c. This phenomenon is greatly extended by examining minerals in polarised light, where many which appear unchanged in common light exhibit this remarkable dicröismal property.

#### TRANSPARENCY.

The degrees of transparency of minerals are ascertained by observing the relative quantity of light which is transmitted through their substance.

These degrees are five.

1. Transparent, if the light be transmitted in sufficient quantity to enable us to distinguish small objects placed behind the mineral.

2. Semi-transparent, if it be possible to see an object behind the mineral, without, however, being able to distinguish more of it than its general outline.

3. Translucent, if a small quantity of light only fall into the mineral, but without allowing an object behind it to be seen.

4. Translucent on the edges, when only the most acute edges of a mineral receive some light, while the interior remains perfectly dark.

5. Opake, when a mineral transmits no light at all. Generally speaking, all the metals, and consequently most of such minerals as possess a perfect metallic lustre, are opake. For this reason, in describing the orders Ore and Metal, the degrees of transparency (there actually being none) are omitted. There are some minerals termed opake, which, if only split thin enough,



are not absolutely so. Specular iron, for instance, when crystallized in thin laminæ, exhibits a dark-red translucent light, while in larger masses and crystals it appears opaque. Even gold, which has the most perfect metallic appearance, and in mass is quite opaque, becomes translucent when beat into leaf, and presents a pale-green colour.

### LUSTRE.

The lustre of minerals is considered in respect to its kind, and in respect to its intensity. The kinds of lustre, according to Mohs, are,

1. Metallic lustre, which is subdivided into perfect and imperfect metallic lustre. The first occurs in all the species of the orders Metal, Pyrites, and Glance, as well as in the wrought metals and most metallic alloys. The second in several ores, as tantalum-ore, uranium-ore, &c.

2. Adamantine lustre, so called from its resemblance to that of diamond, whether in the rough or cut state. It frequently approaches to the metallic, as in certain dark-coloured varieties of carbonate of lead, red silver, and blende.

3. Resinous lustre is such as a body presents if rubbed with oil or greasy matter. It occurs distinctly in pitchstone and idocrase.

4. Vitreous lustre is that of common glass, and may be observed in rock crystal, emerald, chrysolite, and several other gems.

5. Pearly lustre, which is divided into *common* and *metallic* pearly lustre; the first occurring in heulandite, kyanite, several of the micas, &c. The latter in bronzite and hyperstene.

As to the intensity of lustre, the following degrees are distinguished:—Splendent, when the faces produce distinct and well-defined images of the objects. Shining, when the lustre is still lively, but does not produce a distinct image. Glistening, when, though it does not any longer produce an image, it reflects it in patches. Glimmering, when it no more reflects

patches of light, but a mass of undefined light seems spread over the glimmering surface. Dull, when it possesses no lustre at all, as is the case in most decomposed minerals.

### STREAK.

This is a very important characteristic. The colour of a mineral and that of its powder are frequently very different; and as the particular hue of the latter is most easily obtained by rubbing or *streaking* the specimen under examination on a slab of porcelain biscuit, the colour of the powder of a mineral is thence denominated its streak. The streak of white minerals is usually white, that of coloured ones paler than the mass; but when it corresponds with the colour of the mineral, it is said to be unchanged. This is a more constant property than colour; and among the metals (between the magnetic and specular iron ores for instance) is perfectly characteristic.

### CLEAVAGE.

The regular structure of minerals is observed in their cleavage, the irregular structure appears in their fracture; and an individual is said to be cleavable, or to admit of cleavage, if by a mechanical separation of its particles, the regular structure can be rendered visible. Some minerals, by the mere blow of a hammer, divide into fragments contained under flat and even faces, while others afford only a rough and irregular fracture. A crystal of calcareous spar, for instance, whatever be its form, will invariably, when broken, produce rhombs of  $105^{\circ} 5'$ ; and by the help of fine-edged chisels, or other appropriate instruments, distinct cleavages are frequently obtained in minerals, which at first appear entirely devoid of this characterizing property. Cleavage extends the application of crystallography to the productions of the mineral kingdom, and enables us frequently to determine the series of crystallization of individuals and of species, in which crystals are either unknown, or are not



the immediate object of our observation. An accurate knowledge of its peculiarities is moreover useful in recognizing and completing such crystalline forms as are indistinct or imperfect.

A certain degree of skill is required in cleaving minerals. In examining many of them, it is necessary, in the first place, to employ the bright light of a candle, or, better still, of the sun, by the reflection of whose rays the direction of the laminæ may be discerned. The specimen should rest upon a horizontal surface of lead or cloth. The chisel must be applied in its proper place, and in a suitable direction; the blow given to it must be sharp, and every precaution taken to prevent the mineral being powdered or otherwise destroyed. In some cases, however, it must be heated to redness, and plunged into cold water, before fissures can be produced in the direction of the laminæ.

The faces of cleavage are not invariably equal in number, nor are they obtained with equal facility. Several minerals may be cleft into exceedingly delicate laminæ, while others scarcely admit of cleavage at all. Among the first, certain varieties of mica and gypsum exhibit this property in a very remarkable degree; although in these the cleavage to be obtained is only in one direction. Amphibole affords cleavage in two directions, the faces of which are easily obtained, and produce together a rhombic prism of  $124^{\circ} 30'$ . Barytes admits of cleavage with considerable facility into a prism of  $101^{\circ} 42'$ , although there is a third face of cleavage perpendicular to the axis of the prism, which is even more distinct than the other two.

Calc spar, rock-salt, and galena, may be cleft in three directions with equal facility; fluor-spar with still greater ease in the direction of four faces, which together form the octahedron; blende in six, which produce the dodecahedron; and in many other minerals cleavage may be effected in still more directions, differing in number, and often in quality. In these examples the faces are shining and even. Yet this is not constantly the case. Felspar, for instance, one of the most common species of the mineral kingdom, presents three or four different characters on the surface of its cleavages. One of them is shining, even,

and obtained with facility ; another, perpendicular to the first, though equally shining and even, is very far from being so easily produced ; a third is rough, less distinct, and effected with difficulty ; while sometimes there are appearances of a fourth, still less distinct than any of the foregoing.

From what has been stated, it appears that there are some minerals which admit of cleavage in directions which produce only one particular form ; this is termed the *primary, primitive, or fundamental form*. Calcareous spar breaks only into rhombs, which therefore represent the primitive form of that mineral ; the primitive form of rock-salt, in same way, is the cube, and so on.

Now, were there as many different primitive forms as there are distinct species of minerals, we should be easily enabled to discriminate substances by this character alone ; but it is distinctly exhibited in comparatively few species. There are also several minerals, fluor-spar for instance, which afford no less than three different forms, any one of which may with equal probability be considered as its primary form ; blende, in the same way, yields five. Hence the choice of such a form has been arbitrarily assumed by mineralogists, and has been the frequent subject of dispute. We shall, therefore, not enter fully into a department of which so little is as yet accurately known ; and, except in some marked cases, shall omit entirely the question of primary forms.

We must not, however, fail to notice the curious and important fact, that the crystals of a mineral, from what part of the world soever it may be brought, and however dissimilar in external appearance, always possess the same primary form. How it happens that so great diversity of external forms should be derived from the same invariable internal arrangement, is a problem not yet fully resolved ; though explained very comprehensively by Haüy in his beautiful theory of decrements.

## FRACTURE.

The irregular structure presented by a mineral when broken, is termed, in contradistinction to the cleavage, its *fracture*.



Every individual, cleavable or not, may be broken, and therefore fracture is more frequently observable than cleavage. It cannot, however, be of equal use as a characteristic, on account of its irregularity, and from its direction not being constant; a particular in which it essentially differs from cleavage. The principal kinds of fracture are, the *conchoidal*, which frequently resembles the inner surface of a shell, and is of constant occurrence in broken glass, in quartz, obsidian, &c.; and the *uneven* fracture, which designates a more granular structure.

Only these two varieties of fracture, and their transitions, occur among simple minerals. Compound minerals, however, or such as consist of numerous small individuals, whose regular form can no longer be recognized, possess other kinds of fracture, which are also distinguished by mineralogists; such as the *even* fracture; the *splintery*; the *slaty*, when they split only in one direction; the *earthy*, as in chalk; and the *hackly*, a fracture peculiar to the malleable metals, which, when broken, present sharp protruding points.

## THE STRUCTURE,

### *As exhibited in the Double Refraction of Minerals.*

THE phenomenon of double refraction is of frequent occurrence, and in many instances affords a good distinctive character of such minerals as possess it. In explaining it we must keep in mind the well-known phenomenon in optics, that a ray or pencil of light falling obliquely upon any dense transparent medium, such as water or glass, does not continue to proceed in its former rectilinear course, but on entering that medium suffers a change of direction, and is in all ordinary cases bent either towards or from the perpendicular. This phenomenon is named *refraction*, and is either *single* or *double*.

In substances destitute of all crystalline form, such as well annealed glass, or the like, and in many species of the mineral kingdom whose crystalline forms possess certain properties af-

terwards to be noticed, refraction is single; that is, a pencil of common light, when incident upon them, is not split into two, but, whatever its direction, it continues a single pencil after incidence, as it was before it; and of course affords but one image of an object viewed through the refracting medium. If indeed the incident pencil consists of mixed light of various colours, such as that of the sun, then on entering such a medium, the pencil is *dispersed*; for certain rays are more highly refrangible than certain others, and thus certain parts will be farther bent from their original course than certain other parts; and the whole pencil is expanded in the plane in which refraction takes place. This phenomenon is usually exhibited by admitting a sunbeam into a darkened chamber by a circular aperture in the window shutter, then causing it to fall upon a glass prism (which in consequence of its form greatly increases the dispersion of the incident and emergent light), and receiving the image of the sun upon a white screen. This done, some rays in the sunbeam suffer a less, others a greater refraction; and thus the image of the sun upon the screen is not circular, but lengthened in the plane of refraction, so as to be oblong with semicircular ends; and, what is very interesting, it has no longer the colour of the incident light, but displays a beautiful series of tints, from red on the least refracted extremity, through orange, yellow, green, blue, and indigo, to violet on the most refracted extremity. Such a dispersed image of the sun is named the *solar spectrum*, on the structure of which light has latterly been thrown by the researches of Sir D. Brewster. The phenomenon which gives rise to it is named *dispersion*. It is to this property of the rays of light that we owe the rainbow, and that beautiful sparkling and play of colours which certain precious stones exhibit, especially when cut with artificial facets. The light falling upon them is by dispersion resolved into its constituent rays, each of which has a colour of its own, and of which the aggregate only is white or free from tint; and these coloured rays being reflected from the back of the gem, each at its own angle, meet the eye in different points of view, and thus make the facet which reflects them seem a brilliant



green, or blue, or red, or orange, or all in succession, as the case may be.

The phenomenon of dispersion, however, is essentially different from double refraction, to which this section more immediately relates. In order to give the reader an idea of this property, it must be remarked that there are many transparent substances, both in the mineral kingdom and among artificial salts, which, when a pencil of common light is incident upon them, have the property of bisecting it; and thus of presenting a double image of any object viewed through them. This phenomenon is named *double refraction*. It is most readily observed in the transparent calcareous spar from Iceland, or, as it has been termed *par excellence*, doubly-refracting spar. This occurs in rhombic masses; one of which (or indeed any piece of calcareous spar which possesses transparency enough for the purpose) if placed over an object, for instance a black line upon a card, will exhibit two lines of equal brightness in every position of the crystal, except one. In the position alluded to, the one line will be observed to overlap the other; but in the position transverse to that in which they overlap, the separation of the images will be observed to be greatest. These positions indicate very important planes in the crystal; as the overlapping takes place in what is denominated the *principal section*; and the greatest separation, in a plane more nearly coincident than any other afforded by the natural faces, with what is usually termed *the equator of double refraction*. This is a plane at right angles to the crystallographic axis of the rhomboid, which again, is a line that forms the shorter diagonal of the principal section above noticed, and extends between the two obtuse or symmetrical angles, or those two points which, of all those that are opposite, are nearest each other; and which possesses this very interesting property, that a pencil of light transmitted along it is not, as when transmitted in other directions, divided into two. In order to observe this phenomenon, it is only necessary to grind or file away the two obtuse angles of the rhomb, and having polished or anyhow rendered transparent the abraded surfaces, to place the crystal as formerly, over some small object, so as to admit of that

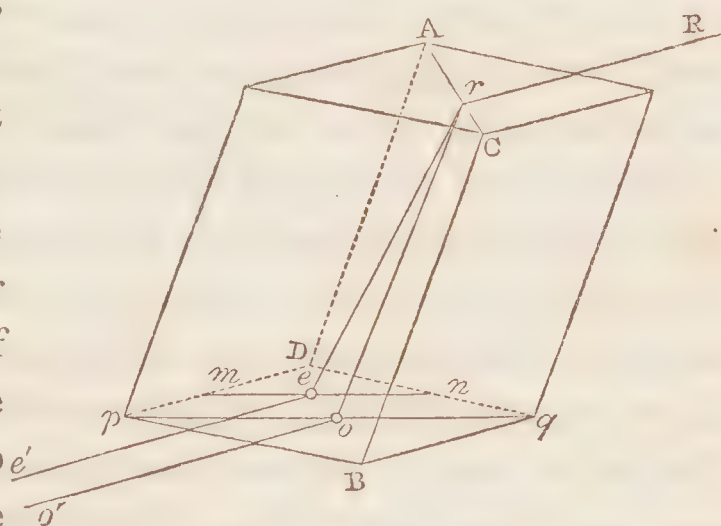
object being viewed along the axis;—this done, it will be observed that the image is not doubled. The line, along which there is no doubling of the image, and consequently no double refraction, is named the *axis of double refraction, or the optic axis*. In calcareous spar, as has been stated, there is only one such (and its parallels) in the mineral; and it is coincident with the crystallographic axis of the rhomboid. But in many other species, instead of one there are two axes of double refraction, which also are not coincident with any eminent line in the symmetry of the crystal, but incline to each other at various angles, whose amount depends on considerations of which we have no knowledge, and somewhat also on the quality of the light which is incident. This would lead us, were we illustrating the subject fully, to the consideration of *resultant axes*; but we hasten to state the fact on account of which chiefly the doctrine of double refraction is interesting to the systematic mineralogist; namely, *that all minerals whose forms belong to the rhombohedral and pyramidal systems of crystallization have only one axis of double refraction, and that, coincident with the axis of symmetry of the crystal considered; while, on the other hand, all minerals whose forms belong to the prismatic system and its subordinates, have two axes of double refraction; and all belonging to the tessular system have either three axes in equilibrio, or are otherwise so constituted in reference to this property, that they do not display any sensible double refraction at all*. This very interesting discovery was made by Sir D. Brewster, after a most extensive and careful examination of mineral species; and subsequent researches have only served to confirm its truth. To that philosopher, indeed, this branch of physics owes in a great measure its existence. By considering the relation of a mineral to double refraction, therefore, we can determine from the number of its axes whether it belongs to the rhombohedral or pyramidal system on the one hand, or whether it may not rather be a member of the prismatic on the other. Farther, however, we cannot judge; for this property affords no distinction between the rhombohedral and pyramidal systems, nor between the prismatic and its subordinates.



The simplest manner of ascertaining if a mineral possess the property of double refraction, is to observe a distant body, as, for instance, a taper, through a proper section of the specimen. If it belongs to the tessular system, only one image will present itself in every aspect; but if to some other system, we shall often obtain indications of two images.

As, however, the images thus presented frequently fall so close together as to overlap, and apparently almost to cover one another, a more effective and beautiful method has been discovered, by which not only the property of double refraction, but the number and direction of the optic axes, may be ascertained. This method consists in examining the crystal in polarized light; to give some idea of the nature of which we must recur to the phenomena of the rhomb of Iceland spar.

In this case, however, instead of supposing, as formerly, the object whence the rays emanate to lie beneath the rhomb, it will be better to suppose a pencil of light, such as  $Rr$ , in the accompanying figure, to be incident upon the



rhomb from above, as, for instance, from the sun. Then, at whatever angle it may fall, even when it comes down perpendicularly, on entering the rhomb it will, as has been stated, be parted into two, forming rays which are equal in intensity, but one bending more from its original course, or suffering a greater refraction, than the other. But it is not in the amount of their actual refraction only that the two pencils thus developed differ from each other; but also in the laws of refraction which regulate their movements. Thus one of them obeys the usual law, that is, it suffers refraction always in the plane of incidence; and so that the sines of the angles of incidence and of refraction maintain a constant ratio. This, therefore, is named the *ordinary ray*. The other, again, obeys a peculiar law: for

except when the plane of incidence coincides with a principal section, or with the equator of double refraction, the refraction does not take place in the plane of incidence; and except in the equator of double refraction it does not obey the ordinary law of the sines: this, therefore, is named the *extraordinary ray*. It hence follows, that in the equator of double refraction both rays obey the same laws; and since the amount of double refraction in this plane is also a maximum, the equator of double refraction seems of all positions the fittest in which to compare the ordinary and extraordinary rays together, and to obtain an expression for the latter. Now, this has been successfully done; and since the formula which is found to express the refraction of the extraordinary ray at any angle with the axis, consists of two parts, namely, that which expresses the refraction of the ordinary ray, together with another quantity connected with the former by the sign *plus* or *minus*, according as the actual refraction of the extraordinary ray in the equator of double refraction is greater or less than that of the ordinary ray, those crystals whose formula has a positive sign between the terms, that is, those whose extraordinary ray is refracted more than the ordinary, are named *positive crystals*. Those, on the other hand, whose formula have the negative sign between the terms, that is, those whose extraordinary ray is refracted less than the ordinary ray, are named *negative crystals*. To the latter class, which is the more numerous, belongs calcareous spar; and of the two rays represented in the preceding figure, *ree'* therefore is the extraordinary ray, *roo'* the ordinary.

But it is not only in the laws of refraction which they obey, that these two rays differ from each other. They possess this most extraordinary property, that when incident at a certain angle upon a reflecting plane, each is capable of being wholly reflected only, or wholly transmitted only, as the case may be; and they possess this most interesting relation to each other, that in the circumstances in which the one is wholly reflected, the other is wholly transmitted, and *vice versa*. Thus let the two emergent rays *ee'* and *oo'* fall upon a smooth surface of water, at an angle of about  $53^\circ$  with the perpendicular, or on



glass, at an angle of about  $56^{\circ}$ ; and it may be observed, that when the principal section of the rhomb AB lies in the plane of incidence and reflection, the ordinary ray  $oo'$  suffers reflection at the surface of the reflecting medium, while the extraordinary ray  $ee'$  is not reflected, but penetrates in its totality, and is transmitted. But on turning round the crystal through a right angle, so that the principal section AB may be transverse to the plane of incidence and reflection, the extraordinary ray  $ee'$ , instead of being transmitted as formerly, suffers reflection at the reflecting surface; and the ordinary ray  $oo'$ , instead of being reflected as formerly, is transmitted. Each in the second position suffers what the other did in the first position. Thus it appears as if the rays had sides or polar aspects; and light reduced to this state has hence been called *polarized light*. The ordinary and extraordinary rays, then, developed out of a pencil of common light by a rhomb of calcareous spar, not only differ in the laws of refraction which they obey, but in this also, that they both consist of polarized light; the plane of polarization of the one being at right angles to that of the other.

In calcareous spar, both pencils developed by double refraction are, as has been stated, of equal intensity, and both are capable of penetrating through a great breadth of the mineral. There are other doubly refracting mineral bodies, however, in which one of the polarized pencils is speedily absorbed, or, to use the language of Newton, “stifled and lost;” and consequently only one is capable of penetrating and of being transmitted. This is the case with tourmaline, a mineral long considered interesting on account of its electrical relations, and now rendered still more so from the property just noticed. When a crystal of one of the coloured varieties of tourmaline is cut in a plane parallel to its axis, and the lamina thus obtained is polished, a pencil of common light incident upon it is dissected by it, as by a rhomb of calcareous spar, into an ordinary and an extraordinary pencil; but in penetrating the lamina, even though of very inconsiderable thickness, the ordinary ray vanishes, and the extraordinary ray is transmitted alone. Hence another

means of obtaining a pencil of polarized light, namely, by transmitting a pencil of common light through a slip of tourmaline cut parallel to the axis of the prism in which it occurs crystallized.

But the simplest of all methods of obtaining a pencil of polarized light, is by reflection from smooth non-metallic surfaces. In order to this, nothing more is necessary than to cause a pencil of common light to fall, at an angle easily determined by experiment, upon any smooth non-metallic surface, such as that of water, a plate of glass or of marble, the surface of a varnished table, japanned tray, or the like. The light reflected will consist of rays polarized in the same plane as the ordinary ray  $oo'$ , sufficiently free from other rays for all the ordinary purposes to which polarized light is put by the mineralogist.

Now, possessed of polarized light by any of the means above described, we are able to detect, with far greater readiness than by simply looking through it, whether a crystal possess double refraction or not; and if it do, whether it possess one or two optic axes. The manner of proceeding is to inspect a section of the crystal in a pencil of polarized light, obtained by some of the methods above described, with a second apparatus placed between it and the eye for polarizing the light again, after transmission through the crystal. When this is done, if the crystal possess the property of double refraction, in some position or other a display of colours, either in diffuse tints, or in one or two systems of rings, may be expected. Thus, when a lamina of calcareous spar, obtained by polishing away the obtuse angles of a small rhomb of that mineral, is held in a pencil of light reflected at the polarizing angle, from a varnished table, japanned tray, plate of glass, or, still better, from a number of such plates superposed; and the light transmitted through the crystal is examined by one of Nichol's single image prisms of calcareous spar, or by a slip of tourmaline or oblique pile of glass plates held close to the eye, a beautiful system of rings will be observed surrounding the axis of the lamina; and in one position, namely, that in which the axis of the tourmaline lies in the plane of incidence and reflection, this system of rings will be traversed by a black cross; while in another position of the



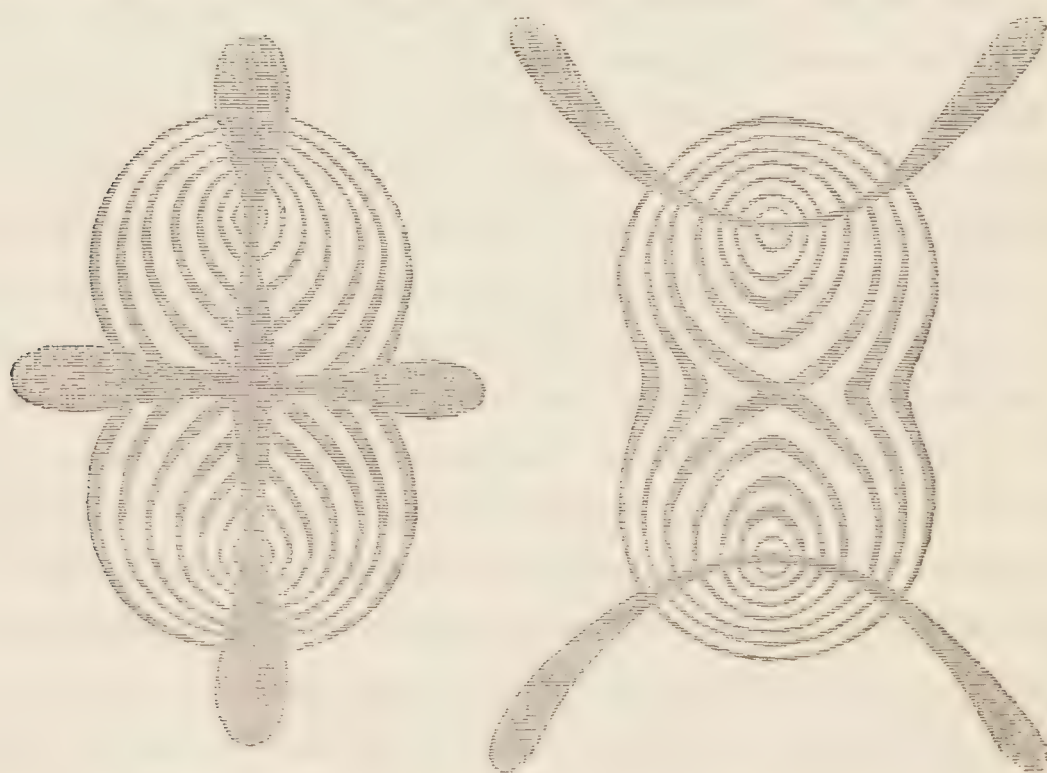
tourmaline transverse to the former, the system of rings seen will be traversed by a transparent cross.



The two systems of rings, seen in these two positions of the tourmaline, owe their existence to the property which this mineral, in virtue of its double refraction, possesses, of depolarizing the light which it transmits, or rather of disposing it anew in two pencils equal to each other in intensity, and polarized in transverse planes. Except in what relates to the cross, they seem to be in every respect similar; though in fact they are not the same system, but two systems complementary to one another, and so related, that if accurately superposed, the one would just neutralize the other, and leave nothing visible but a simple transparency in the mineral. Hence we are led to suppose, that the reason why no rings are seen when we look at the lamina in polarized light with the naked eye only, is because both systems appear simultaneously. But when the tourmaline is interposed, it absorbs the rays which form the one system of rings, and transmits only those which form the other; and thus enables us to see the one unneutralized, by the simultaneous accession of the other to the eye. Or when, instead of Nichol's prism or the tourmaline, we use the oblique pile of glass slips before the eye (which has this advantage over the tourmaline, that it does not impair the tint of the colours seen), and transmit through it the light coming through the crystal, then in one position it discharges by reflection one of the pencils transmitted from the crystal, and propagates to the eye the other only; and in a transverse position propagates

to the eye that which it discharged before, and discharges that which it propagated before. The pile of glass plates may also be used as a reflector, as in the analyzing plate of the common instrument.

Such are the phenomena presented when a crystal possessing one axis of double refraction is examined in polarized light. In one which possesses two axes the phenomena are more complicated, and, if sometimes less symmetrical, are not less curious or beautiful. To observe them most easily, a small lamina cut from a crystal of nitre, so that its opposite faces may be as nearly as possible perpendicular to the axis of the prism in which that salt crystallizes, may be taken and inspected in the manner already described. In four positions at right angles to each other, an elliptical or rather lemniscoidal combination of coloured bands, formed round the two optic axes, and symmetrically traversed by a cross, will then be observed; while in the four immediate positions, the second of the following forms will be



developed; and the transition of one of these forms into the other may be distinctly traced, by causing the polarizing eye-piece, whether tourmaline, pile of glass slips, or reflecting plate, to revolve. Besides nitre, there are many other crystalline bodies, such as borax, aragonite, &c. which display analogous phenomena.

But the colours exhibited by thin laminæ of sulphate of lime



are amongst the most brilliant ; and in order to observe them, no more is necessary than to procure a film of that mineral, from the twentieth to the sixtieth of an inch in thickness, and to hold it between two polarizing media, the tourmaline eye-piece and the polarizing reflector for instance, as in the other cases. This done, in four positions it will be found to be tinted with the most brilliant colour or colours, according as it is of one or of various degrees of thickness ; and in reference to its tints the same thing is to be observed as in the colours seen around the optic axes of minerals when they form complete rings, namely, that by causing the axis of the tourmaline to revolve through a right angle, we always get a tint or set of tints, complementary to that obtained in the first position, or such that both taken together give white light. Thus, suppose that with the polarizing reflector horizontal (as, for instance, a varnished table), and the axis of the tourmaline in a vertical plane, we find that the lamina of gypsum displays a red tint ; then, by causing the axis of the tourmaline to revolve through a right angle, so as to become horizontal, we shall find that, after becoming at a certain period of the revolution colourless, the lamina of gypsum will display a green tint corresponding in intensity to the red, and so related to it, that both, when made to overlap each other, give limpidity or whiteness. That such is really the case may at once be discovered by substituting for the analysing eye-piece a doubly refracting medium, such as a rhomb of calcareous spar, or one of the doubly refracting prisms of rock crystal of Rochon, which gives both pencils to the eye simultaneously. This done, the colours of the two images will be observed to be complementary to each other ; and the region where they overlap will be observed to be limpid, as if viewed by the naked eye.

To describe these phenomena with greater minuteness, would be incompatible with the objects of this treatise, and is the less necessary from its having already been so well done elsewhere. There are many other peculiarities also in the crystalline structure of minerals, which the use of polarized light reveals, such as the phenomena exhibited by apophyllite, analcime, amethyst, glauberite, and others, to which we must

now merely allude, referring for farther information on this most curious subject to the valuable papers of Sir David Brewster in the Edinburgh Journal of Science, and the Transactions of the Royal Societies of London and Edinburgh ; to the article Optics in the Edinburgh Encyclopædia, by the same philosopher ; to that on Light in the Encyclopædia Metropolitana, by Sir John Herschel ; and to the concise view of the subject, given in the two recent treatises on Double Refraction and Polarization, in the Library of Useful Knowledge.

### VARIOUS OTHER EXTERNAL CHARACTERS.

Cleavage and fracture, as already remarked, designate the regular or irregular structure of minerals ; but as other varieties of structure are frequently presented, the consideration of which does not come under either of these heads, it is requisite here to notice the following.

The *fibrous* structure presents a surface composed of fine threads or fibres, sometimes so minute and closely disposed, that the mineral would appear compact, were it not for its delicate striated texture. On the other hand, the fibres are frequently large enough to admit of being measured ; and if much increased in size, this structure may be viewed as passing into the foliated. The direction of these fibres may be *straight* or *curved* ; their relative position may be *parallel* or *diverging* ; or they may be *radiated*, in which case they proceed from a common centre.

The *foliated* or *laminated* structure appears in minerals composed of thin plates or laminæ. When such minerals are broken in the direction of the laminæ, their surface appears smooth and shining like the surface of a crystal, and therefore this species of structure is with propriety considered the result of crystallization. In this structure the magnitude of the laminæ varies considerably ; in some cases a single plate extends through the whole mass ; in others the plates appear in scales so minute as scarcely to be discernible, except by the reflection of light from their polished surfaces.



*Slaty* structure is exhibited in minerals composed of somewhat thick and extensive layers or plates, whose surfaces, however, are not smooth and polished, as in those which are foliated.

The *granular* structure is seen in minerals composed of grains either large or small, but still visible to the eye, as in sandstone. When the grains are not discernible in consequence of their minuteness, it is said to have a *compact texture*.

The *waxy* texture is that which resembles the fracture of bees' wax, and is particularly exemplified in some varieties of compact felspar.

*Frangibility* may also be said to depend on structure. It is that resistance which minerals oppose when an attempt is made to break them into fragments, and must not therefore be confounded with hardness. Quartz, for instance, is hard, and hornblende comparatively much softer; yet the latter is less easily frangible than the former. The degrees of frangibility range from *very brittle* to *very tough*. Sulphur and the sulphate of lead are said to be *very brittle*; galena and red silver, *easily frangible*; hornstone and quartz, *less easily frangible*; and the native malleable metals, *very tough*. These degrees are, however, so extremely arbitrary, and in many minerals vary, from exposure or partial decomposition, to such an extent, as to render frangibility of very minor importance in characterizing the species.

*Flexibility* serves as one among the distinctive characters of the few minerals which possess it. That substance is said to be flexible, which continues, when bent, in the form it receives.

*Elasticity*, on the other hand, denotes the property which certain minerals possess of springing back to their former position on being bent. Thus gypsum and talc are flexible; and by this character alone the latter may be distinguished from mica, which is very elastic.

*Touch* is principally characteristic of some friable minerals. Thus the feel of soapstone is *unctuous*; that of chalk is said to be *meagre*.

The *taste* is a mode of discriminating saline species, some of them communicating an astringent, cooling, or metallic taste, when applied to the tongue; others a pungent, a bitter, or a sa-

line taste. All bodies which afford this property are of course soluble in water.

*Odour* is characteristic of only a small number of minerals. Mineral pitch and naphtha are said to have a *bituminous*, native sulphur a *sulphureous*, and swinestone, when struck or rubbed, a *fetid* odour. Some argillaceous minerals, if breathed upon, smell like clay; and there are many of the metallic ones, such as arsenical- and iron-pyrites, which, when rubbed forcibly by harder bodies, emit peculiar odours.

*Adhesion of the tongue* depends upon the disposition of a mineral to imbibe moisture, and may be remarked in some varieties of calcedony and opal; as also in many decomposed species.

*Phosphorescence* is elicited either by heat or friction; but as it is extremely variable in respect of colour, and has no fixed relation to that of the mineral; as it occurs only in some varieties, while it is totally wanting in others of the same species, and frequently disappears after the first experiment,—it may with greater propriety be considered as a curious property, than as a useful character of the minerals which possess it. Fluor, particularly the variety called from this circumstance chlorophane, when thrown in small fragments on iron heated nearly to redness, exhibits this property in a remarkable degree; and if not exposed to too intense a temperature, it will continue to do so repeatedly. Some varieties of blende, that from Kapnick for instance, exhibit a phosphoric light when scratched with a knife; as do several dolomites, and the limestones of Sala and Langbanshyttan in Sweden, when struck with a hammer. The diamond affords light in the dark after being exposed for some time to bright sunshine; as also do the Bolognese stone (a variety of barytes), and many others.

*Magnetism* is a property met with almost exclusively in ores of iron, though even among them it is dependent on their several states of oxydation. Magnetic or oxydulated iron, for instance, presents this property very distinctly; while in specular iron it is much less strongly marked, and in hematite is scarcely observable. There are, however, a good many minerals which become magnetic on exposure to the blowpipe.



A common magnet is sufficient for ascertaining this property ; but in making experiments with large masses of minerals, it is convenient to employ a needle of feeble power ; for if it be greatly superior to that of the mineral, the latter will attract both poles of the magnet. When, on the other hand, it is very difficult to ascertain the presence of this property, the specimen should be crushed to powder, and the magnetic needle or bar dipped among the debris ; in which case, if it exist at all, a portion of the powder will attach itself to the needle.

*Electricity* is an interesting property of minerals, and there are several which afford that phenomenon. In some of them it is excited by friction, in others by pressure ; in some by communication, and in others by heat. Sulphur and amber, for instance, when rubbed, will attract cotton, down, fur, or any other light substance ; and, generally speaking, all precious stones are easily excited, while metallic minerals are just as much the reverse. Crystals of tourmaline, topaz, and some others, present, when heated, different states of electricity at their opposite terminations ; and in boracite, two sides of the crystals exhibit positive, and two negative electricity.

The neatest little instrument for ascertaining the electricity of minerals is the Electrometer, which consists of a metallic needle, terminated at each end by a small ball, and traversing easily upon a pivot. It has a metallic support, which, to be isolated as much as possible, should be fixed into a piece of sealing-wax. Before making an experiment, it must be kept in remembrance that there are two kinds of electricity, which are denominated *positive* and *negative*, or *vitreous* and *resinous*, according as they are excited by smooth glass, or by some resinous substance. It must also be recollected, that when two bodies possess the same kind of electricity, whether positive or negative, they repel each other ; but if one possess positive electricity, and the other negative, they attract one another. If, then, the mineral which has been excited either by friction or heat, be presented to one of the balls of the electrometer, the needle will turn, whether the electricity be positive or negative ; and the force of the electricity may be estimated by the distance at which

the needle begins to move. To determine what kind of electricity a mineral possesses, the needle must be previously electrified, which is done either positively or negatively by exciting either a tube of glass or a stick of sealing-wax, placing one finger on the metallic base of the electrometer, and then bringing the excited glass or sealing-wax within a small distance of one of the balls. When sufficiently electrified, first withdraw the finger, and then remove the glass or sealing-wax. If, now, an excited mineral be presented to the needle, the ball will be repelled from or attracted to it, according as it possesses the same or opposite kinds of electricity; and the degree of electricity of the needle being known, that of the mineral will at the same time be determined.

The appearance of the *surface* of crystals is in many cases worthy of particular attention, being sometimes sufficiently decided to afford a distinct characteristic. The faces of crystals, generally speaking, are smooth and brilliant, though at times they are rough, striated, or uneven. The intensity of their lustre is proportional to the perfection of the crystals; and the smoother the faces of cleavage, the more completely does the mineral possess that property. The striæ upon some faces of crystallization is a very remarkable peculiarity, being always parallel to the edges of combination, and thereby affording an easy mode of determining homologous faces. In quartz, for instance, whose form is usually that of a six-sided prism terminated by a six-sided pyramid, the faces of the prism are streaked horizontally, an arrangement occasioned in the formation of the crystal by the alternate appearance, though to an extremely limited extent, of the faces of the prism and the pyramid. The same may be observed in tourmaline, beryl, iron pyrites, and many other minerals.

#### THE PARASITIC FORMATION OF MINERALS.

There are some minerals which present externally the well-known form of a particular species, which, on being broken up,



are found to consist of a totally different one. To these the name of *pseudomorphous* or *parasitic* minerals is applied, to denote the intrusive nature of the new compounds, and their prevalence over those which existed before. These minerals, then, are the results of a parasitic formation, in which the particles of the original substance have by degrees been totally replaced by others.

In the *first* place, we find changes existing in substances having similar composition,—an occurrence not unfrequent in some varieties of salt, but which may be familiarly illustrated in barley-sugar. The whitish coat with which that substance, when kept for some time, becomes covered, exhibits a fibrous structure, the direction of the fibres being perpendicular to the surface of the specimen. When decomposition proceeds farther, crystals of sugar-candy are formed in the space previously occupied by a homogeneous mass, which presented the most perfect conchoidal fracture, and not a trace of crystalline structure.

*Secondly*, We have changes dependent on the presence of water. The absorption of water by the atmosphere causes some saline substances to deliquesce, and to change their form in passing from one state of aggregation to another. Others, on the contrary, effloresce by losing their water, and are converted into a loose mass of a pulverulent consistency, which retains its original shape, but readily gives way to the pressure of the finger, and falls into powder. Haüy's *chaux sulfatée épigène* is an instance of this kind of parasitic formation, being anhydrite changed into gypsum by combining with a portion of water.

*Thirdly*, Changes in minerals containing copper. Many of the crystals from Chessy in France, presenting the form of blue copper, are composed of fibrous malachite ; perfect and continuous passages from one extreme to the other are only to be observed in large collections, but it is nevertheless a fact of no rare occurrence. Instances of the red copper ore changed into blue copper are found in the same locality, differing in this respect, however, that in red copper the surface first turns green by the absorption of oxygen and water, and then the decomposition penetrates deeper into the mass ; whereas in blue copper

the surface of the crystals is the last portion which is converted into malachite, since the decomposition begins from the point of support. Copper, in its pure metallic state, also affords examples of parasitic formation, as may be observed at times in some of the remains of ancient vessels, which are so completely disintegrated that they admit of being broken with the hand. When this is the case, the fracture will be found to represent a compound mass full of small drusy cavities, in which octahedral crystals of red copper are distinctly visible. Sometimes also the surface of such vessels is coated with minute crystals of muriate of copper. (See Haidinger in Brewster's Journal, VIII. 129.)

*Fourthly*, Changes in minerals containing iron. Of these, the most marked instance is the alteration of sparry-iron, which is originally of a pale yellow or greyish colour, and presents considerable lustre and transparency, into hydrate of iron, a substance devoid of cleavage, having an uneven earthy fracture, and a dark-brown colour. Eisenerz in Styria, and Huttenberg in Carinthia, afford innumerable specimens of this peculiarity.

*Fifthly*, Changes in minerals containing lead. Some of the most interesting examples of parasitic formation exist among the ores of lead from Leadhills in Scotland. Large cubes of what had once been galena are here found to consist of the rarer species of sulphato-carbonate, sulphato-tri-carbonate, cupreous sulphate, and cupreous sulphato-carbonate, as well as of phosphate, carbonate, and sulphate of lead. A piece of galena, with bright cleavage planes, is often engaged among all these species; and in that case its surface appears corroded and rounded, like calc-spar which has been exposed to the action of acid, or rock-salt to the dripping of water. The mineral known by the name of blue lead presents the converse of this. It consists of granular galena, filling six-sided prisms, which originally consisted of phosphate and chloride of lead; at Huelgoet in Brittany, six- and twelve-sided prisms are found, often upwards of an inch in length, and nearly half an inch in thickness, which consist of a coarse-grained compound variety of galena; the



component parts being so large, it is easy to ascertain their hexahedral cleavage.

The number of species in which these remarkable changes are exhibited, is quite extraordinary. Baryto-calcite and witherite frequently occur in crystals whose surfaces have lost their original brightness, and are covered with a white coating. In both cases this coating consists of minute crystals of sulphate, which has taken the place of carbonate of baryta. In the trap district of Dumbarton we have specimens exhibiting the shape of analcime, but entirely composed of aggregate crystals of prehnite; at Wheal Maudlin in Cornwall, wolfram taking the pyramidal form of tungsten; and at Wheal Coates in the same county, tin presenting that of twin crystals of felspar. The texture of the last is granular and incoherent, but neither the substance nor the form can be mistaken. Quartz, more than any other species, is known to fill up the vacuities previously occupied by crystals of calcareous spar, of fluor, and of gypsum. Thus we have quartz in the shape of fluor at Beeralston in Devonshire; hornstone in that of calcareous spar at Schneeberg in Saxony; and calcedony in that probably of fluor, from Treszt्यान in Transylvania.

There are other minerals, as the haytorite from Devonshire, of whose constitution there can be no doubt, but the derivation of whose form has given rise to the most contradictory hypotheses. Another substance which has long perplexed mineralogists is the steatite from Gœpfersgrün, in Bayreuth, which presents the forms of quartz, calcareous spar, and pearl spar, without the slightest indication, either in the appearance or composition of the surrounding mass, of any of these minerals having ever been present.

Such are some of the most remarkable and familiar instances of the changes which may take place in the solid body of a crystal. The parasitic formation of minerals is, however, a subject we are little acquainted with; and our knowledge of the facts, as well as of their causes, is up to this moment scanty and imperfect. It may be remarked, however, that in general the surface of these pseudomorphic minerals is less smooth and

brilliant than that of the crystals of the same species ; and that the interior of many of them is hollow, or is filled with fluid.

The examination of crystals formed from solutions is frequently of great value to the mineralogist. Such crystals may often be obtained in much greater variety and perfection than natural crystals having similar chemical composition ; and in following up the late experiments of M. Beudant, who proceeded so far as to produce at will one or other of certain possible modifications, some very interesting results may be exhibited. For instance, it is well known that common salt crystallizing in pure water affects almost always the cubical form ; but if crystallized in a solution of boracic acid, it assumes the form of the cube with truncated angles. Sulphate of iron has commonly a simple form ; but by adding a few drops of sulphuric acid, more complex forms are obtained. Alum in concentrated solution of alumine assumes the cubical form, and on being replaced in a solution adapted to afford octahedral crystals, it again assumes the octahedron. It is impossible not to be tempted to refer phenomena such as these, occurring, as they so often do, in natural crystals, to similar circumstances which have prevailed when the crystals have been forming.

### CHEMICAL COMPOSITION.

The analytical portion of mineralogy belongs to the chemist. It is for him to obtain the ingredients of mineral species in most perfect purity, and to ascertain their relative quantities. It forms no part of our present object to describe the manner in which he pursues his researches.

The chemical formulæ of Berzelius, like the signs and symbols of many mineralogical authors, though convenient to the advanced chemist, are rather calculated to perplex than to facilitate our progress. They are therefore omitted in the description of the species, though the compounds they respectively indicate are occasionally added in common language.



## ACTION OF ACIDS.

Acids act powerfully on many minerals, and frequently form an important feature in ascertaining their nature. A small fragment of the mineral, or a portion of it reduced to powder, is dropped into a tubular glass, and covered with diluted acid. For this purpose muriatic acid is generally employed, as the native carbonates effervesce and are soluble in it; though in most cases nitric or sulphuric acids may be used with equal effect. When effervescence ensues, it is important to notice the rapidity and degree of that action. Sometimes, as in calcareous spar, the effervescence is brisk, and the solution rapid; in others, even when pulverized, as in dolomite, it is slow and scarcely apparent. Sometimes the solution is complete; sometimes a residue is left; and occasionally, as in mesotype, the produce is gelatinous.

In most cases this process is carried on at the common temperature of the air; in others by the application of gentle heat.

## THE BLOWPIPE.

When crystalline structure, specific gravity, cleavage, and other external characters fail to afford us the necessary means of discriminating minerals, we should frequently feel ourselves at a loss, without the aid of this portable and invaluable instrument. For though we cannot by its means arrive at the definite proportions of the elements of a mineral, it affords a general insight into the constituent principles, and indicates the best and least expensive method of treating the substance on an enlarged scale. It affords the only practicable way of ascertaining whether the inferences we have drawn from external characters (such as form, hardness, or colour) be correct; and it frequently even detects the presence of substances neither sought for nor expected in the body under examination.

The blowpipe is an instrument too well known to require minute description; but its utility can scarcely be said to have been matured, until it fell into the hands of Berzelius. It con-

sists of a tube seven or eight inches in length, adapted to suit the vision of the operator, and terminated by a beak about an inch long, which is perforated with a minute hole, so that it may act upon the flame of a candle. That of Berzelius is furnished with a cylindrical receiver, through which the air passes, in order to prevent its being accompanied with moisture; and on one side of this receiver, at right angles with the tube, the beak is placed. The whole instrument should be made of silver, with the exception of the point of the beak, which is usually formed of platina. Blowpipes are of course frequently constructed of less costly materials; but when of brass or other metal, are extremely apt to get out of order; and glass does not stand the necessary heat.

The blowpipe introduced by Wollaston is a simpler and much more elegant instrument. It consists of a thin cylindrical tube about seven inches long, the end of which is inserted nearly at right angles into a small beak of a similar form. The tube is constructed of two pieces, which are made to slip one within the other, and the beak fitting at same time its larger extremity, affords a pocket blowpipe, in size and shape resembling a pencil-case.

The effect intended to be produced by the blowpipe, when properly applied to the flame of a candle, is to procure a steady stream of intensely heated gaseous matter, which can with facility be directed upon the object under examination. This, with a little practice, is easily managed, without calling the organs of respiration into increased action, or in the least impeding their functions. The operator breathes through the nostrils at the same time that, by the muscles of his lips and cheeks, he forces a continued stream of air from the anterior part of his mouth through the blowpipe.

The Berzelian apparatus consists of a numerous set of instruments, and is as remarkable for its amplitude, as that of Wollaston is for the reverse. As the former is fully described by Berzelius himself, in Mr Children's translation of his treatise on the blowpipe, it is unnecessary here to enter into details. Every mineralogist will in the course of practice adopt his own



methods, and will learn to apply the most ready means within his reach to attain his object. The following instruments, however, are indispensable :—

Forceps, having their prongs at one extremity made of steel, and at the other of platina, for holding the laminæ of a mineral in the flame, when we wish to ascertain its fusibility.

Cutting pliers, made thick and strong in their cutting part, for detaching small portions from a specimen.

A penknife for kneading in the palm of the left hand, and taking up portions of the fluxes and of the pulverized mineral.

A couple of files, and hammers of small size and of different shapes, for chipping as occasion may require.

A piece of polished steel, for crushing fragments of minerals, or trying the malleability of a grain of reduced metal. This ought to be kept in a leather cover, to prevent the slightest approach to rust. A small agate mortar and pestel, free from crevices or cracks; a platina spoon, and a store of platina-wire and foil; a few variously-sized glass tubes; and, what a mineralogist need scarcely be reminded of, a microscope with one or two lenses of different powers.

When the blowpipe is much used, as in the hands of glass-blowers and jewellers, an oil-lamp specially adapted is generally resorted to. But a wax-taper of moderate size will commonly answer the purposes of the mineralogist. The wick should be cut short, and turned away from the point of the instrument, so that the stream of air may be blown along it horizontally, and as near as possible without touching the wick. If properly directed, it will produce a lengthened conical flame of a delicate blue colour, surrounded with another which has a faint red appearance. The highest temperature is produced a little beyond the apex of the inner or *reducing* flame, at a point where it is mixed with unconsumed carbon; while the outer is denominated the *oxidating* flame, from the facility with which oxidation proceeds at an incipient red heat. The power of thus obtaining reduction or oxidation, as the operation may require, is one of the most valuable properties of the blowpipe.

The portion of mineral to be acted upon should be no larger

than is requisite to afford a distinct view of the effect of heat upon it. The best and most common support\* for the experiment, is a piece of well-prepared charcoal of as close a texture as can be obtained. To prevent the mineral from escaping, a small cavity is usually made in the support; this has, besides, the effect of concentrating the heat, which, it is calculated, may be brought up, when well applied, to 150° of Wedgewood.

When the substance under examination sinks into the charcoal, or is affected by its inflammable quality, a platina spoon must be employed, or a bit of platina foil, folded into the shape best adapted for the experiment. When the mineral contains volatile matter which it is wished to examine, the portion to be experimented upon is placed within a glass tube, and heat applied either by means of a spirit-lamp or of the blowpipe, according to the required temperature. By this means the volatile substances not permanently gaseous condense, and are sublimated in the upper part of the tube, where their nature may be ascertained. The presence of water is determined in the same way; a tube closed at one end, and enlarged according to circumstances, so as to form a flask or matrass, being the most convenient instrument for that purpose. Minerals which are apt to decrepitate when exposed to heat, may be secured in the same manner; for decrepitation being but a momentary phenomenon, they may, after being once heated to redness, be treated without any envelope.

The alterations caused by the action of the blowpipe upon minerals are extremely various; and it is the facility with which such changes may be observed, by being directly before the eye, which renders that instrument, when applied to the mouth, so highly preferable to any machine worked by artificial means. It is valuable also, from the limited differences of heat that can be produced by its means, and the consequent ease with which the relative fusibility of minerals may be

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\* The substance or instrument by means of which the object under examination is exposed to the flame, is called the support.



determined. On some minerals the blowpipe produces no effect whatever, others are partially fused, and others again melt with great ease. Sometimes their colour is changed, or entirely disappears. Some minerals decrepitate, others divide or exfoliate, when exposed to the flame; some become indurated, and contract in bulk; others effervesce, or, rising in little frothy blisters, melt with intumescence. Some are merely softened on the edges, and are altered in their shape, or if the substance be in loose grains, these become agglutinated; others are converted into a kind of porcelain, in which only a few points are vitrified. Some melt into a *slag*, or vitreous substance containing metallic matter; others yield a tumefied mass, or are reduced into a *scoria*, which is light and porous; some afford an *enamel*, which has a vitreous aspect, but is not transparent, and in some cases is only superficial; and others yield a globule of perfect *glass*, which in different substances has various colours, and possesses different degrees of transparency. The phosphate of lead, after being reduced into a globule, while cooling suddenly, starts into a polyhedral crystal of a greenish colour and glassy aspect; and innumerable are the effects produced by different processes on different species. These and all similar changes must be carefully noted, even the vapour or odour evolved during the experiment, the colour which some minerals communicate to the flame, their phosphorescence, and every other phenomenon which may lead to the detection of elements whose presence was not anticipated, or perhaps even suspected.

After having observed the alteration which the substance undergoes by the mere action of heat, it will be necessary to examine what farther change takes place when it is melted with various fluxes, and how far it is capable of reduction to the metallic state. Of these fluxes, or *re-agents* as they are termed, the most invaluable for their respective purposes are the three proposed (we may truly say) in the infancy of the science by Cronstedt. These are,

1. The carbonate of soda, which is used for ascertaining by its means whether bodies be fusible or not, and for assisting the reduction of metallic oxides.

2. Borax, which is employed in effecting the fusion of a great number of substances.

3. Salt of phosphorus, or microcosmic salt, a compound of phosphoric acid, soda, and ammonia, which, as it shows the action of acids on the assays, is particularly applicable to the examination of metallic oxides.

There are of course a variety of other uses to which each of these may be rendered subservient, and of which the skilful operator with the blowpipe will soon learn to avail himself; but as in some cases effects are required to be produced, which do not come within the reach of any of them, the test-box should also contain compartments for the following substances.

4. Oxide of copper, to detect the presence of muriatic acid.

5. Iron, in the state of very thin wire, for ascertaining the presence of phosphorus.

6. Tin, in the form of foil, for promoting reduction in the fused vitreous compounds.

7. and 8. Gypsum and fluor spar, which, when well dried, are used mutually to detect each other.

9. Bisulphate of potash and fluor, mixed in the proportion of four and a half of the former to one of the latter, for ascertaining the presence of boracic acid. With respect to this last, Dr Turner's instructions are, to mix about equal parts of it with the mineral under examination, forming them, by the addition of a little moisture, into a paste on the palm of the hand. A small particle of the mixture is then taken up on platina-wire, and exposed to the blowpipe flame, not at its apex, but somewhat nearer the wick than the point of the blue flame. Fusion takes place, and at the moment it does so, that portion of the flame beyond the assay is tinged of a pale-green colour. This effect is most distinct and unequivocal, but the operation requires some care; for the green colour appears but for an instant, at the very commencement of fusion; and having once ceased, it cannot be made to appear again, however long the blast may be continued. (See Turner's papers in Brewster's Journal.)

The presence of lithia may be detected in minerals by a simi-



larly easy and expeditious method. Petalite or spodumene, for instance, when exposed to the action of the blowpipe, does not at first admit of fusion; but when the blast is continued, and a small portion of fluor added, fusion at length occurs, and at the same moment a distinct red hue is imparted to the flame. This is an important test in the examination of the micas; such of them as contain lithia fusing without addition readily, and tinging the flame red, while those that are free from lithia neither fuse nor produce that colour.

10. Another very useful re-agent is a solution of the nitrate of cobalt in water, which, when concentrated, is employed to ascertain the presence of alumina and magnesia, affording with the former a fine blue, and with the latter a pale rose colour.

It is unnecessary, in a treatise like the present, to enter more at length on the subject of the blowpipe. Suffice it to say, that the above re-agents are of highest importance in the examination of metallic minerals. The ores of the difficultly reducible metals, such as manganese, cobalt, chrome, and titanium, are characterized by the colours which their oxides give to glass. In all these cases, therefore, glassy fluxes must be largely made use of, both to dissolve the earthy matter with which the oxides are generally combined, and to furnish a body with little or no colour of its own, which may receive and sufficiently dilute the inherent colour of the oxide. When the colour thus produced is so intense as to appear opaque, it is requisite to flatten the glass, before it becomes solid, between a pair of forceps, or to draw it out into a thread at the instant it begins to cool.

A description of the comportment of each species, when exposed to the action of the blowpipe, is shortly mentioned in the body of the work, under their respective heads; and for further instruction, both as to the mode of performing experiments, the phenomena presented, and the results afforded by them, the reader is referred to the excellent work of Berzelius on the use of the blowpipe, as translated by Mr Children.

The Oxy-hydrogen or Compound blowpipe is an instrument less generally useful, though an important one when an intense degree of heat is required. In it the heat arises from the combustion of an united stream of hydrogen and oxygen, before which every substance, however refractory, is forced to give way. Platina exposed to it fuses instantly; palladium melts like lead; alumina and silica run into globules; gold is volatilized; plumbago forms a magnetic bead; jade, mica, and asbestos, melt like wax; and even the diamond is consumed and dispersed into vapour.

No method, however, answers better when a high temperature is desired, than the *blowing table*, the construction of which is simple and easy, wherever the operator can command a stream of coal gas. In this instrument the gas issues through a longitudinal burner, about two inches long, and perforated by two rows of minute orifices. The interval between these rows is from one sixth to one fifth of an inch. The blast is procured by forcing air from a pair of bellows, wrought by the foot, into a *blowing cistern*, from which the pressure of a column of water, displaced by the air from the bellows, flows out in an equable stream through the gas flame. The force of the blast is regulated by a stopcock, and the size of the orifice of the blowpipe is of course made to suit the operator.

This contrivance affords a fine and powerful flame, admirably suited to the purposes of the mineralogist and the glass-worker; and forms one of the most indispensable implements of the chemical laboratory.



# SYNOPSIS

OF THE

## ARRANGEMENT.

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### I. ORDER.—ACID.

Sp. Gr. = 1·3—3·7. Taste Acidulous.

- |                  |                    |
|------------------|--------------------|
| 1. Boracic Acid. | 2. Arsenious Acid. |
|------------------|--------------------|

### II. ORDER.—SALT.

Sp. Gr. = 1·2—2·9. H. undetermined. Not acid.

- |                   |                         |
|-------------------|-------------------------|
| 1. Natron salt.   | 12. Glauberite.         |
| 2. Glauber salt.  | 13. Polyhalite.         |
| 3. Nitre.         | 14. Mascagnine.         |
| 4. Rock salt.     | 15. Botryogene.         |
| 5. Ammoniac salt. | 16. Misy.               |
| 6. Green vitriol. | 17. Nitrate of soda.    |
| 7. Blue vitriol.  | 18. Sulphate of cobalt. |
| 8. White vitriol. | 19. Sulphate of potash. |
| 9. Epsom salt.    | 20. Trona.              |
| 10. Alum.         | 21. Gay-lussite.        |
| 11. Borax.        | 22. Oxalate of iron.    |

### III. ORDER.—HALOIDE.

Sp. Gr. = 2·2—3·3. H. 1·5—5·0.

Devoid of metallic lustre. Streak uncoloured.

If Sp. Gr. does not exceed 2·4; H. is under 2·5, and there is no resinous lustre.

If cleavage is single and presents perfect faces; Sp. Gr. is under 2·5.

If pyramidal, prismatic, or hemi-prismatic; H. rarely exceeds 4·0.

If tessular; H. 4·0 at least.

- |                  |                          |
|------------------|--------------------------|
| 1. Gypsum.       | 12. Herderite.           |
| 2. Anhydrite.    | 13. Scorodite.           |
| 3. Pharmacolite. | 14. Aragonite.           |
| 4. Haidingerite. | 15. Calcareous spar.     |
| 5. Cryolite.     | 16. Dolomite.            |
| 6. Hopeite.      | 17. Breunnerite.         |
| 7. Alum-stone.   | 18. Ankerite.            |
| 8. Wavellite.    | 19. Childrenite.         |
| 9. Kakoxene.     | 20. Carbonate of cerium. |
| 10. Fluor-spar.  | 21. Magnesite.           |
| 11. Apatite.     | 22. Roselite.            |

### IV. ORDER.—BARYTE.

Sp. Gr. = 3·3—7·3. H. 2·5—5·0.

Not metallic. Streak uncoloured, or orange-yellow.

If streak be orange-yellow; Sp. Gr. amounts to 6·0 at least, and H. is under 3·0.

If H. is 5·0; Sp. Gr. is below 4·5.

If lustre be adamantine or imperfect metallic; Sp. Gr. is equal to 5·0 at least.

- |                   |                       |
|-------------------|-----------------------|
| 1. Sparry iron.   | 3. Silicate of zinc.  |
| 2. Red manganese. | 4. Carbonate of zinc. |



- |                                        |                                             |
|----------------------------------------|---------------------------------------------|
| 5. Tungsten.                           | 18. Cupreous sulphato-carbonate<br>of lead. |
| 6. Strontites.                         | 19. Cupreous sulphate of lead.              |
| 7. Witherite.                          | 20. Muriate of lead.                        |
| 8. Barytes.                            | 21. Murio-carbonate of lead.                |
| 9. Celestine.                          | 22. Tungstate of lead.                      |
| 10. Baryto-calcite.                    | 23. Plomb-gomme.                            |
| 11. Carbonate of lead.                 | 24. White antimony.                         |
| 12. Phosphate of lead.                 | 25. Fluuate of cerium.                      |
| 13. Chromate of lead.                  | 26. Phosphate of yttria.                    |
| 14. Molybdate of lead.                 | 27. Stromnite.                              |
| 15. Sulphate of lead.                  | 28. Phosphate of iron and man-<br>ganese.   |
| 16. Sulphato-tri-carbonate of<br>lead. |                                             |
| 17. Sulphato-carbonate of lead.        |                                             |

## V. ORDER.—KERATE.

Sp. Gr. above 5·5. H. = 1·0—2·0.

Not metallic. Streak uncoloured.

- |                        |                        |
|------------------------|------------------------|
| 1. Chloride of silver. | 2. Muriate of mercury. |
|------------------------|------------------------|

## VI. ORDER.—TERENE.

Sp. Gr. 1·7—3·9. H. = 0·5—3·0.

If possessing a distinct cleavage ; appearance metallic.

If streak is uncoloured ; lustre is resinous, or Sp. Gr. under 2·0.

When Sp. Gr. exceeds 3·0 ; colour black or blue.

- |                        |                      |
|------------------------|----------------------|
| 1. Black cobalt ochre. | 8. Iron sinter.      |
| 2. Kupferindig.        | 9. Chrysocolla.      |
| 3. Cupreous manganese. | 10. Gänsekothig-erz. |
| 4. Wad.                | 11. Allophane.       |
| 5. Pyr-orthite.        | 12. Halloysite.      |
| 6. Hisingerite.        | 13. Kollyrite.       |
| 7. Graphite.           |                      |

## VII. ORDER.—MALACHITE.

Sp. Gr. 2·8—4·6. H. = 2·0—5·0.

No true metallic lustre. Colour blue, green, or brown. Streak coloured.

If streak is blue ; H. does not exceed 4·0.

- |                                    |                                 |
|------------------------------------|---------------------------------|
| 1. Lenticular arseniate of copper. | 8. Hydrous phosphate of copper. |
| 2. Arseniate of iron.              | 9. Green carbonate of copper.   |
| 3. Acicular arseniate of copper.   | 10. Muriate of copper.          |
| 4. Phosphate of copper.            | 11. Strahlerz.                  |
| 5. Blue carbonate of copper.       | 12. Erinite.                    |
| 6. Diopase.                        | 13. Brochantite.                |
| 7. Euchroite.                      | 14. Kupfersammterz.             |

## VIII. ORDER.—MICA.

Sp. Gr. 2·8—3·4. H. = 1·0—4·5.

Not metallic. Cleavage highly perfect in one direction.

If H. exceeds 3·0 ; rhombohedral.

- |                  |                          |
|------------------|--------------------------|
| 1. Copper-mica.  | 7. Chlorite.             |
| 2. Kupferschaum. | 8. Mica.                 |
| 3. Uranite.      | 9. Talc-mica.            |
| 4. Cobalt bloom. | 10. Margarite.           |
| 5. Vivianite.    | 11. Hydrate of magnesia. |
| 6. Cronstedtite. | 12. Pyrosmalite.         |

## IX. ORDER.—STEATITE.

Sp. Gr. 2·5—2·9. H. = 1·5—4·0.

Colour dirty-green or brown, passing into white.

- |                  |                |
|------------------|----------------|
| 1. Soap stone.   | 3. Serpentine. |
| 2. Agalmatolite. | 4. Gieseckite. |



- |               |                  |
|---------------|------------------|
| 5. Fahlunite. | 8. Picrolite.    |
| 6. Pinite.    | 9. Picrosmine.   |
| 7. Killinite. | 10. Pyrallolite. |

## X. ORDER.—SPAR.

Sp. Gr. 2·0--3·7. H. = 3·5--7·0.

Not metallic. Streak uncoloured, brown or blue.

If tessular; Sp. Gr. does not exceed 3·0.

If rhombohedral; Sp. Gr. either under 2·2, or H. above 6·0.

If H. is not above 4·0; either cleavage is highly perfect in one direction, or it belongs to the rhombohedral system.

If H. above 6·0; lustre is pearly, cleavage perfect, and Sp. Gr. either above 2·8 or under 2·5.

- |                   |                   |
|-------------------|-------------------|
| 1. Diallage.      | 22. Skolezite.    |
| 2. Bronzite.      | 23. Thomsonite.   |
| 3. Hyperstene.    | 24. Comptonite.   |
| 4. Anthophyllite. | 25. Stilbite.     |
| 5. Kyanite.       | 26. Heulandite.   |
| 6. Diaspore.      | 27. Epi-stilbite. |
| 7. Spodumene.     | 28. Brewsterite.  |
| 8. Prehnite.      | 29. Mesole.       |
| 9. Datolite.      | 30. Apophyllite.  |
| 10. Leucite.      | 31. Davyne.       |
| 11. Sodalite.     | 32. Herschellite. |
| 12. Analcime.     | 33. Petalite.     |
| 13. Sarcolite.    | 34. Nepheline.    |
| 14. Harmotome.    | 35. Felspar.      |
| 15. Phillipsite.  | 36. Pericline.    |
| 16. Chabasie.     | 37. Albite.       |
| 17. Levyne.       | 38. Anorthite.    |
| 18. Gmelinite.    | 39. Labradorite.  |
| 19. Laumonite.    | 40. Scapolite.    |
| 20. Natrolite.    | 41. Edingtonite.  |
| 21. Mesotype.     | 42. Latrobite.    |

- |                            |                   |
|----------------------------|-------------------|
| 43. Nuttallite.            | 57. Thulite.      |
| 44. Elaolite.              | 58. Lazulite.     |
| 45. Augite.                | 59. Calaité.      |
| 46. Babingtonite.          | 60. Saussurite.   |
| 47. Hornblende.            | 61. Nephrite.     |
| 48. Arfwedsonite.          | 62. Eudialite.    |
| 49. Epidote.               | 63. Bergmannite.  |
| 50. Wollastonite.          | 64. Chiasolite.   |
| 51. Bucklandite.           | 65. Gehlenite.    |
| 52. Amblygonite.           | 66. Kapholite.    |
| 53. Jeffersonite.          | 67. Sillimanite.  |
| 54. Acmite.                | 68. Biotine.      |
| 55. Silicate of manganese. | 69. Somervillite. |
| 56. Withamite.             |                   |

## XI. ORDER.—GEM.

Sp. Gr. 1·9—4·7. H. = 5·5—10·0.

Not metallic, and devoid of metallic lustre. Streak uncoloured.

If Sp. Gr. under 3·8; no pearly lustre on faces of cleavage.

If H. under 6·0; Sp. Gr. not above 2·4, and no traces of form and cleavage:

- |                 |                  |
|-----------------|------------------|
| 1. Andalusite.  | 14. Isopyre.     |
| 2. Spinel.      | 15. Axinite.     |
| 3. Automalite.  | 16. Chrysolite.  |
| 4. Corundum.    | 17. Chondrodite. |
| 5. Chrysoberil. | 18. Boracite.    |
| 6. Diamond.     | 19. Tourmaline.  |
| 7. Topaz.       | 20. Idocrase.    |
| 8. Euclase.     | 21. Helvine.     |
| 9. Emerald.     | 22. Garnet.      |
| 10. Iolite.     | 23. Staurolite.  |
| 11. Quartz.     | 24. Zircon.      |
| 12. Opal.       | 25. Fibrolite.   |
| 13. Obsidian.   | 26. Forsterite.  |



- |                |                 |
|----------------|-----------------|
| 27. Humite.    | 31. Sapphirine. |
| 28. Ligurite.  | 32. Sphærolite. |
| 29. Ostranite. | 33. Zeagonite.  |
| 30. Mellilite. |                 |

## XII. ORDER.—ORE.

Sp. Gr. 3·4—7·4. H. = 2·0—7·0.

Streak not green.

If metallic; colour black.

If not metallic; lustre adamantine or imperfect metallic.

If streak be red or yellow; H. = 3·5 and more; and Sp. Gr. 4·8 or more.

If streak be brown or black; H. above 5·0 or under 2·5, or single distinct cleavage.

If H. not exceeding 2·5; Sp. Gr. under 5·0.

If H. not exceeding 4·5; streak yellow, red, or black.

If H. = 6·5 or more, and streak uncoloured; Sp. Gr. 6·5 and more.

- |                       |                       |
|-----------------------|-----------------------|
| 1. Gadolinite.        | 18. Cerine.           |
| 2. Allanite.          | 19. Chromate of iron. |
| 3. Orthite.           | 20. Titanitic iron.   |
| 4. Sphene.            | 21. Crichtonite.      |
| 5. Pyrochlore.        | 22. Magnetic iron.    |
| 6. Rutile.            | 23. Franklinite.      |
| 7. Anatase.           | 24. Specular iron.    |
| 8. Brookite.          | 25. Brown iron ore.   |
| 9. Red oxide of zinc. | 26. Lievrite.         |
| 10. Red copper ore.   | 27. Polymignite.      |
| 11. Tin ore.          | 28. Stilpnosiderite.  |
| 12. Wolfram.          | 29. Hausmanite.       |
| 13. Tantalite.        | 30. Braunite.         |
| 14. Yttro-tantalite.  | 31. Psilomelane.      |
| 15. Fergusonite.      | 32. Grey manganese.   |
| 16. Uranium ore.      | 33. Pyrolusite.       |
| 17. Cerite.           |                       |

## XIII. ORDER.—METAL.

Sp. Gr. 5·7—20·0. H. = 0·0—5·0.

Metallic. Colour not black.

If colour be grey; malleable, and Sp. Gr. 7·4 and more.

If H. above 4·0; malleable.

- |                       |                    |
|-----------------------|--------------------|
| 1. Arsenic.           | 9. Mercury.        |
| 2. Tellurium.         | 10. Silver.        |
| 3. Antimony.          | 11. Gold.          |
| 4. Antimonial silver. | 12. Iridium.       |
| 5. Arsenical silver.  | 13. Palladium.     |
| 6. Bismuth.           | 14. Platina.       |
| 7. Native lead.       | 15. Native iron.   |
| 8. Amalgam.           | 16. Native copper. |

## XIV. ORDER.—PYRITES.

Sp. Gr. 4·1—7·7. H. = 3·0—6·5.

If H. = 4·5 and less; Sp. Gr. under 5·3.

If Sp. Gr. 5·3 and less; colour yellow or red.

- |                       |                                 |
|-----------------------|---------------------------------|
| 1. Copper nickel.     | 7. Nickeliferous grey antimony. |
| 2. Arsenical pyrites. | 8. Iron pyrites.                |
| 3. Mispickel.         | 9. Cockscomb pyrites.           |
| 4. Grey cobalt.       | 10. Magnetic pyrites.           |
| 5. White cobalt.      | 11. Buntkupfererz.              |
| 6. Cobalt-kies.       | 12. Copper pyrites.             |

## XV. ORDER.—GLANCE.

Sp. Gr. 4·2—7·6. H. = 1·0—4·0.

Metallic. Colour grey or black.

If cleavage single, and Sp. Gr. under 5·0; colour lead grey.

If Sp. Gr. above 7·4; colour lead grey.



- |                            |                                   |
|----------------------------|-----------------------------------|
| 1. Tin pyrites.            | 13. Graphic tellurium.            |
| 2. Bournonite.             | 14. Grey antimony.                |
| 3. Vitreous copper.        | 15. Jamesonite.                   |
| 4. Fahlerz.                | 16. Sulphuret of silver and an-   |
| 5. Tennantite.             | timony.                           |
| 6. Sulphuret of silver.    | 17. Berthierite.                  |
| 7. Galena.                 | 18. Zinkenite.                    |
| 8. Foliated tellurium.     | 19. Brittle silver ore.           |
| 9. Sulphuret of molybdena. | 20. Flexible sulphuret of silver. |
| 10. Sternbergite.          | 21. Seleniuret of silver and cop- |
| 11. Sulphuret of bismuth.  | per.                              |
| 12. Needle ore.            |                                   |

## XVI. ORDER.—BLENDE.

Sp. Gr. 3·9—8·2. H. = 1·0—4·0.

Streak green, red, brown, or uncoloured.

If metallic; black.

If not metallic; adamantine lustre.

If streak green; colour black.

If streak brown or uncoloured; Sp. Gr. between 4·0 and 4·2, tessular.

If streak red; H. not above 2·5.

If Sp. Gr. exceed 4·3; streak red.

- |                            |                                |
|----------------------------|--------------------------------|
| 1. Sulphuret of manganese. | 4. Red silver ore.             |
| 2. Blende.                 | 5. Hemi-prismatic ruby blende. |
| 3. Red antimony.           | 6. Cinnabar.                   |

## XVII. ORDER.—SULPHUR.

Sp. Gr. 1·9—3·6. H. = 1·0—2·5.

Not metallic. Colour yellow, red, or brown.

Prismatic or hemi-prismatic.

If cleavage is single; Sp. Gr. is 3·4 and more.

If Sp. Gr. above 2·1; streak yellow or red.

- |                     |             |
|---------------------|-------------|
| 1. Yellow orpiment. | 3. Sulphur. |
| 2. Red orpiment.    |             |

## XVIII. ORDER.—RESIN.

Sp. Gr. 0·7—1·6. H. = 0·0—2·5.

If fluid; has a bituminous odour.

If Sp. Gr. above 1·2; streak uncoloured.

- |             |              |
|-------------|--------------|
| 1. Mellite. | 3. Bitumen.  |
| 2. Amber.   | 4. Retinite. |

## XIX. ORDER.—COAL.

Sp. Gr. 1·2—1·5. H. = 1·0—2·5.

Streak brown or black.

- |                 |                |
|-----------------|----------------|
| 1. Common coal. | 2. Anthracite. |
|-----------------|----------------|

## APPENDIX.

- |                                          |                       |
|------------------------------------------|-----------------------|
| 1. Æschynite.                            | 17. Chamoisite.       |
| 2. Aluminite.                            | 18. Chelmsfordite.    |
| 3. Alumocalcite.                         | 19. Chloropal.        |
| 4. Amphodelite.                          | 20. Chlorophæite.     |
| 5. Anglarite.                            | 21. Cobaltic galena.  |
| 6. Antimonphyllite.                      | 22. Conite.           |
| 7. Argentiferous sulphuret<br>of copper. | 23. Copper black.     |
| 8. Arsenical antimony.                   | 24. Cotunnite.        |
| 9. Arsenical bismuth.                    | 25. Courzeranite.     |
| 10. Berzeline.                           | 26. Cummingtonite.    |
| 11. Beudantite.                          | 27. Cupreous bismuth. |
| 12. Bismuth cobalt ochre.                | 28. Dermatine.        |
| 13. Bismuthic silver.                    | 29. Dysclasite.       |
| 14. Bole.                                | 30. Erlamite.         |
| 15. Breislakite.                         | 31. Fluellite.        |
| 16. Bustamite.                           | 32. Fuller's Earth.   |
|                                          | 33. Gibbsite.         |



- |                                           |                          |
|-------------------------------------------|--------------------------|
| 34. Glaucolite.                           | 63. Protheéite.          |
| 35. Green iron earth.                     | 64. Pynguite.            |
| 36. Hatchetine.                           | 65. Pyrargyllite.        |
| 37. Hedyphan.                             | 66. Pyrophyllite.        |
| 38. Heteposite.                           | 67. Reussite.            |
| 39. Huraulite.                            | 68. Scarbröite.          |
| 40. Hydrosilicite.                        | 69. Scheererite.         |
| 41. Indianite.                            | 70. Seleniuret of lead.  |
| 42. Johannite.                            | 71. Silicate of cerium.  |
| 43. Karphosiderite.                       | 72. Soda alum.           |
| 44. Kerolite.                             | 73. Sordawalite.         |
| 45. Knebelite.                            | 74. Sulphate of alumina. |
| 46. Krokydolite.                          | 75. Sulphuret of nickel. |
| 47. Marmolite.                            | 76. Tautolite.           |
| 48. Mohsite.                              | 77. Telluric silver.     |
| 49. Molybdena silver.                     | 78. Tephroite.           |
| 50. Monticellite.                         | 79. Thorite.             |
| 51. Native carbonate of lime<br>and soda. | 80. Titaniferous cerite. |
| 52. Nemalite.                             | 81. Torrelite.           |
| 53. Nontronite.                           | 82. Tripoli.             |
| 54. Osmelite.                             | 83. Turnerite.           |
| 55. Peganite.                             | 84. Uran-bloom.          |
| 56. Pektolite.                            | 85. Vanadate of lead.    |
| 57. Pelokonite.                           | 86. Vauquelinite.        |
| 58. Pimelite.                             | 87. Wagnerite.           |
| 59. Plumbo-calcite.                       | 88. Wolchonskoite.       |
| 60. Polybasite.                           | 89. Xanthite.            |
| 61. Polysphærite.                         | 90. Yellow tellurium.    |
| 62. Poonahlite.                           | 91. Yttro cerite.        |
|                                           | 92. Zurlite.             |

## ERRATA.

- Page 18, Syn. of Oxalate of Iron—Humboldtine, *Rivero*.  
— 33, line 3, *pro* Shiefer Spar *lege* Schiefer Spar.  
— 42, Syn. of Red Manganese—Rhodochrosit, *Haus*.  
— 84, Syn. of Kupfersammterz—Velvet Blue Copper, *J*.  
— 131, line 2, *pro* avytic *lege* Davytic.  
— 137, — 2, *pro* Cleavlandite *lege* Cleavelandite.  
— 155, — 17, *pro* Siliferous *lege* Siliciferous.  
— 207, — 21, *pro* 14·85 *lege* 16·85.  
— 252, — 23, *pro* Arsenical Pyrites, *J*. Di-prismatic Arsenical Iron,  
*lege* Di-prismatic Arsenical Pyrites, *J*. Arsenical Iron.  
— 270, — 21, *pro* Silicate of manganese *lege* red manganese.  
— 320, — 12, *pro* Sulphuret of Alumina *lege* Sulphate of Alumina.



# DESCRIPTION.

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## ORDER ACID.

### BORACIC ACID.

Prismatic Boracic Acid, *M.* Sassoline or Native Boracic Acid, *J.* Boraxsaure, *L.* Acide Boracique, *H.*

Sp. Gr. 1·4 to 1·5.

Prismatic. *Form* six-sided tables, but not easily determined. Incoherent scaly particles of a greyish or yellowish-white colour, the latter arising from a slight mixture with sulphur. *Lustre* pearly. *Taste* acidulous and slightly bitter. Soft and greasy to the touch. The variety from Volcano is, according to Stromeyer, pure boracic acid with an accidental mixture of sulphur, and is essentially a compound of boron 25·83, and oxygen 74·17.

It fuses easily at the flame of a candle, and yields a transparent glassy globule, which becomes opaque on cooling, if there be any gypsum in combination. When dissolved in spirits of wine it communicates to the flame a fine green tinge, a test which affords the best indication of the presence of boracic acid. It bleaches moistened Brazil-wood paper in the course of half an hour, and turns turmeric paper damped with alcohol brown.

#### OBSERVATIONS.

The most celebrated deposit of this substance is the Solfatara within the crater of Volcano, one of the Lipari Isles, where it is sublimated in the form of a thin filament or cake on the surface of the sulphur, and around the *fumeroles* whence these exhalations arise. This incrustation consists of small flaky particles of a delicate silky-white colour, very soft, and so greasy to the touch that a portion invariably sticks to the finger; it is seldom above half an inch thick, frequently presents a fibrous structure, and is always more or less tinged with sulphur. It also occurs both massive and pulverulent, in which last case the particles are disposed as a loose covering on the surface of the sulphur, without any attachment or adhesion to each other. Dr Holland was the first person (in 1812) who noticed this substance in the crater of Volcano. Boracic acid is likewise

deposited by some of the *lagunes* in Tuscany, and at the hot-springs of Sasso, a locality which has procured for it the trivial name of *Sassoline*. The mineral from these deposits, however, differs materially in appearance from that of Volcano; it is greyer in the colour, considerably harder, and shows traces of crystallization; moreover, according to Klaproth's analysis, the Tuscan variety contains boracic acid 86·00, sulphate of magnesia 11·00, sulphate of lime 3·00, the two latter ingredients being totally foreign to the variety from Volcano.

For economical purposes it is obtained at Pomorance in Tuscany, by causing the volcanic vapours which arise in that vicinity to pass through water, and then evaporating the impregnated fluid in leaden vessels. By this means a very pure boracic acid is deposited in large crystalline flakes, which are collected as an article of commerce for the manufacture of borax.

### ARSENIOUS ACID.

Octahedral Arsenic Acid, *M.* Oxide of Arsenic, *J.* and *P.* Arsenikbluthe, *L.* Arsenik-saure, *Haid.* Arsenic Oxidé, *H.*

Sp. Gr. 3·698.  $H. = 1·5.$

**Tessular.** *Form* the octahedron, though in general it occurs investing other substances in minute capillary crystals, aggregated in stars, or in botryoidal and stalactitic masses. *Colour* white, sometimes accidentally tinged yellow or red; varying from semi-transparent to opaque. *Lustre* vitreous. *Taste* astringent. *Cleavage* octahedral. *Fracture* conchoidal. It consists of arsenic 75·82, oxygen 24·18.—Berzelius. It is soluble in hot water, and when exposed to a high temperature is volatilized without any odour; but when heated with inflammable matter, the acid is decomposed, and the strong garlic smell which characterizes metallic arsenic is emitted.

### OBSERVATIONS.

This substance bears much similarity to pharmacolite, and has often been confounded with it; but it is soluble in water, which that mineral is not. Its principal locality is the Katherina Grube at Andreasberg in the Hartz, where it is found accompanying ores of silver, lead, and arsenic, and to the decomposition of some of which it probably owes its origin. It has likewise been found at Joachimsthal in Bohemia, at Kapnik in Hungary, and in the old mines of Biber in Hanau. In some of the Hartz furnaces it is frequently obtained by sublimation, and in such cases it presents large distinct octahedral crystals. Its poisonous effects are sufficiently known.



## ORDER SALT.

### NATRON SALT.

Hemi-Prismatic Natron Salt, *M.* Prismatic Natron, *J.* Carbonate of Soda, *P.* Egyptian Natrum, *Klapr.* Naturliches Mineral-Alkali, *W.* Soda, *Haus.* Kohlensaures Natron, *L.* Soude Carbonatée, *H.*

Sp. Gr. 1.5. H. = 1.0—1.5.

Hemi-prismatic. FIG. 25. Inclination of P to P =  $79^{\circ} 41'$ ; of M to M =  $76^{\circ} 28'$ ; of the edge between PP to that between MM =  $121^{\circ} 8'$ . Generally massive or fibrous. *Colour* white or greyish. Translucent or semi-transparent. When fresh, compact; but upon exposure becomes loose and opaque. *Taste* pungent. *Lustre* vitreous. *Cleavage* parallel to a face which bevels the edge PP. *Fracture* conchoidal. *Surface* smooth and even. The native carbonate of soda from Egypt was found by Klaproth to consist of dry carbonate of soda 32.6, sulphate of ditto 20.8, muriate of ditto 15.0, and water of crystallization 31.6. It has a decidedly alkaline taste, is very soluble in water, and its solution changes blue vegetable colours green. It also effervesces with acids, and melts easily before the blowpipe.

#### OBSERVATIONS.

In nature the crystals are rarely found sufficiently distinct to admit of our ascertaining their precise forms. Being a salt which loses its water on exposure to a dry atmosphere, it is commonly met with in the state of efflorescent powder on the surface of the earth, on the sides of lakes, or in natural caverns. I have observed it in small quantities within the crater of Vesuvius, sublimated among the crevices of hot lava; and it is not uncommon to find it attached to the roofs and sides of old mines and cellars. It occurs in considerable quantities in the plain of Debretzin in Hungary, where, during the heat of summer, it appears in saline efflorescences resembling heaps of snow (*Phil. Jour.* VII. p. 260); also in Bohemia and Italy, but principally in the soda lakes of Egypt. It is met with likewise in the water of certain hot springs, as those of Carlsbad in Bohemia, and Rykum in Iceland. Its chief employment is in the manu-

facture of soap, but it enters also into the composition of glass, and is used in dyeing, bleaching, &c. both in its natural state and when purified by chemical processes.

The *Trona*, so frequently confounded with this substance, is a totally different species. See page 16.

### GLAUBER SALT.

Prismatic Glauber Salt, *M.* and *J.* Sulphate of Soda, *P.* Naturlich Glaubersalz, *W.* Glaubersalz, *Haus.* Schwefelsaures Natron, *L.* Soude Sulfatée, *H.*

Sp. Gr. 1.48. H. = 1.5—2.0.

In nature it is seldom found crystallized, but occurs in efflorescences of a greyish-white colour, or in an earthy form, in the neighbourhood of rock salt or brine springs; also in the galleries of old mines. *Colour* white. *Lustre* vitreous. Transparent. *Taste* saline and bitter. *Cleavage* perfect in one direction. *Fracture* conchoidal. It is easily soluble in water, but decomposes readily on exposure to the air, and falls into powder. The native salt consists of sulphate of soda 67.02, carbonate of soda 16.33, muriate of soda 11.00, carbonate of lime 5.64.—Reuss.

#### OBSERVATIONS.

Its principal localities are the salt mines in the Salzkammergut of Upper Austria, Hallein in Salzburg, Hungary, and Egypt. It is however not an uncommon ingredient of hot springs, as at Carlsbad, Eger, and Sedlitz in Bohemia. When purified from the foreign matter it is usually associated with, or when prepared artificially, it is used in medicine under the appellation of Glauber Salt, and in some countries is employed as a substitute for soda in the manufacture of glass.

The *Thenardit* of Cordier (Brewster's Journal, vi. p. 182) is an almost pure sulphate of soda, and will most probably be found to belong to this species.

### NITRE.

Prismatic Nitre Salt, *M.* Prismatic Nitre, *J.* Nitrate of Potash, *P.* Naturlicher Salpeter, *W.* Salpeter, *L.* Potasse Nitratée, *H.*

Sp. Gr. 1.9—2.0. H. = 2.0.

Prismatic. FIG. 26. Inclination of P to P over the apex =  $72^{\circ} 17'$ ; of M to M about  $120^{\circ}$ . Crystals of a small size have been found at Fiume in Sicily, but these are very rare, and it is usually met with in fibres and thin crusts. *Colour* white. Semi-transpa-



rent. *Lustre* vitreous. *Streak* white. *Taste* saline and cooling. Sectile. *Cleavage* parallel to *h* and *M*, though not very perfect. Brittle. It dissolves easily in water, is not altered by exposure to the air, deflagrates when placed on a hot coal, and detonates with combustible substances. That from the Pulo di Molfetta in Apulia consists of nitrate of potash 42·55, sulphate of lime 25·45, muriate of lime 0·20, carbonate of lime 30·40.—Klaproth. The chemical composition of the crystals of pure nitre is 55·28 potash, and 44·72 nitric acid.

## OBSERVATIONS.

Though found in considerable quantity in Spain and Hungary, in the state of Kentucky, in a valley near Mount Sinai in Arabia, in Egypt, Persia, and near Agra in Bengal, this salt is not produced naturally to an extent sufficient for its multiplied uses. It is therefore principally procured artificially from the decomposition of animal and vegetable matter. (See Ure's Dictionary.) Its chief employment is in the manufacture of gunpowder, of which it constitutes 75 or 76 per cent.; but it is also used in medicine, in making nitric acid, in the preservation of meat, &c. In India it is employed for the preparation of cooling mixtures; an ounce of powdered nitre dissolved in five ounces of water reduces its temperature fifteen degrees.

## ROCK SALT.

Hexahedral Rock Salt, *M.* and *J.* Common Salt, Muriate of Soda, *P.* Natürlich Kochsalz, *W.* Steinsalz, *L.* Soude Muriatée, *H.*

Sp. Gr. 2·2—2·3. *H.* = 2·0.

Tessular. The cube; sometimes fibrous or stalactitic. If pure, colourless or white; but when with any foreign admixture, presents a variety of tinges from flesh red to Berlin blue. Often transparent. *Lustre* vitreous. *Streak* white. When scratched with the nail, receives an impression, but yields no powder. *Taste* saline. *Cleavage* parallel to the faces of the cube. *Fracture* conchoidal. The rock salt of Cheshire consists, according to Henry, of muriate of soda 98·32, sulphate of lime ·65, muriate of magnesia ·02, muriate of lime ·01, undissolved matter 1·00.

Pure rock salt may be considered as a compound of 40·5 sodium and 59·5 chlorine, or, according to the old view, of 53·29 soda and 46·71 muriatic acid. It attracts moisture, and is easily soluble in three times its weight of water, but remains unaltered in a dry

atmosphere. When a solution of muriate of soda (whether rock or bay salt) is evaporated rapidly, it crystallizes in hollow four-sided pyramids; but when the solution is allowed to evaporate spontaneously, it forms regular cubes. These crystals contain no water of crystallization, but decrepitate remarkably when heated, owing to the sudden vaporization of water mechanically confined in them. The native rock salt containing no water, fuses at a red heat without any decrepitation.

#### OBSERVATIONS.

There is perhaps no individual article more important or indispensable for the support of animal life than salt, and it is worthy of remark that this mineral is almost universally distributed over the face of the globe. It has been found in very elevated regions, as well as at a great depth below the soil; commonly, however, it occurs in large irregular beds, associated and intermixed with gypsum, polyhalite, clay, sandstone, and calcareous spar. Its principal European deposits are the salt mines of Wieliczka in Poland, those of the Salzkammergut in Upper Austria, Hallein in Salzburg, Hall in the Tyrol, Bex in Switzerland, and Northwich in Cheshire; all of which afford extensive annual supplies for culinary and other economic purposes, though generally in such an impure state as to make the process of solution and subsequent evaporation indispensable. In Cheshire, where the salt occurs with a comparatively small proportion of foreign matter, it is occasionally fitted for use by merely crushing it between iron rollers. But in the Austrian mines, where it is invariably mixed with much clay, a totally different plan is resorted to. Large chambers are formed in the mines, and filled with fresh water from the surface, which attacking the sides and roof, dissolves the salt, and leaves the clay and extraneous matter to settle at the bottom. After ten days or a fortnight, when the solution becomes sufficiently saturated, the brine is run off to the evaporating houses, and another supply of fresh water admitted; and this is repeated thirty or forty times, till the chamber becomes so extensive as to endanger the roof, and threaten destruction to the interior works. In Cheshire the salt occurs in a basin-shaped deposit, and is arranged in orbicular masses, resembling, in structure, the Corsican granite, but varying from five to eight feet in diameter. The masses are formed of concentric coats, and, in consequence of their contiguity to each other, present polygonal figures, which the concentric coatings maintain throughout the mass. This remarkable formation has not been observed elsewhere. Muriate of soda is also obtained by evaporation, to the extent of three or four per cent. from sea water; likewise from various mineral wells; salt-springs, as at Halle and Luneburg in Germany, and Salina in the United States; and salt-lakes, of which there are several of considerable extent in the Crimea, in the isle of Cyprus, and in Northern Africa.



With respect to the different varieties of this mineral, the finest crystallized specimens come from the mines of Wieliczka near Cracow, which are said to have been worked since the year 1250; and from Bex in Switzerland. At Northwich it is often clear and transparent, but rarely exhibits traces of distinct forms, except in the fracture; while the Austrian and Tyrolese varieties are most commonly impure, but present some splendid colours, varying from ash grey to flesh red, brick red, Berlin and violet blue, and, what is very rare, occasionally light green tinges. I have seen a cubical-shaped specimen of the deep blue coloured variety at the mines of Hallstadt, which was at least six inches in diameter; but even there it is of rare occurrence. Curious specimens of rock salt are sometimes found forming efflorescences on the sides of caves, and in the pyramids of Egypt. Some white stalactitic masses are deposited by sublimation among the lava within the craters of volcanos, as at Vesuvius; and both in Switzerland and Sicily it frequently accompanies sulphur. The fibrous and nearly transparent variety called *Spak*, from the Wieliczka mines, is considered by Breithaupt a particular species; but, except that it differs slightly in taste from the common salt, its components and relation are so nearly the same as to make it undeserving any such distinction.

Besides the employment of this mineral for culinary purposes, its uses in many metallurgic operations, in the manufacture of earthen ware, soap, soda, &c. are well known. In agriculture it is given to cattle, and used as manure.

### AMMONIAC SALT.

Octahedral Ammoniac Salt, *M.* Octahedral Sal-Ammoniac, *J.* Muriate of Ammonia, *P.* Natürlicher Salmiak, *W.* Salmiak, *L.* Ammoniaque Muriatée, *H.*

Sp. Gr. 1.528.  $H. = 1.5 - 2.0$ .

Occurs in regular octahedrons of a very small size, sometimes in stalactitic or globular masses, in crusts, or as an efflorescence. *Colour* when pure, white, but generally greyish or yellow. *Translucent* or opaque. *Streak* white. *Taste* saline and pungent. *Cleavage* octahedral. *Fracture* conchoidal. Two varieties analyzed by Klaproth were found to consist of—

	Vesuvius.	Bucharia.
Muriate of ammonia	99.5	97.50
Sulphate of ammonia	0.5	2.50

In its pure state it is a compound of ammonia 32.06, muriatic acid 51.16, water 16.78.

This salt dissolves readily in about three times its weight of water, but does not attract moisture on exposure to the atmosphere. It is completely volatile at a high temperature, rising in

white fumes, and emits a pungent smell of ammonia if moistened and rubbed with quicklime. If a saturated solution of this salt in hot water be allowed to cool, its surface will soon be covered with feathery masses of aggregated crystals, which in a short time sink to the bottom.

## OBSERVATIONS.

The best known localities of ammoniac salt are the cracks and fissures in the immediate vicinity of active volcanos, among which it occurs as a product of sublimation. Considerable masses were found within the crater of Vesuvius during the eruption of 1822. At *Ætna*, in the Solfatara near Naples, and particularly on the island of Volcano, it occurs in its natural state, though by no means in sufficient quantity to meet the demand. Indeed hitherto it has nowhere been discovered to an extent sufficient to make it worth the collecting, and therefore all that is used in dyeing, medicine, and otherwise, is produced by chemical processes. Small quantities occur sometimes in the vicinity of ignited coal seams, as at St Etienne in France, and even amongst those of Newcastle and Scotland. It has likewise been found in Bucharía. Sal ammoniac is employed in medicine, and in several metallurgical operations. Copper-smiths make use of it to prevent the oxidation of metallic surfaces when under the operations of tinning and soldering. For the purposes of commerce it used to be obtained chiefly from Egypt, where it was prepared artificially, but it is now also largely manufactured in Europe.

## GREEN VITRIOL.

Hemi-prismatic Vitriol Salt, *M.* Rhomboidal Vitriol or Green Vitriol, *J.* Sulphate of Iron, *P.* Eisen Vitriol, *L.* Fer Sulfaté, *H.*

Sp. Gr. 1·83. H. = 2·0.

Hemi-prismatic. FIG. 27. Inclination of *f* to *f* over the edge  $x = 82^{\circ} 21'$ ; of *b* to *f* =  $99^{\circ} 23'$ ; of *b* to the edge  $x = 104^{\circ} 20'$ . Rare in distinct crystallizations, generally massive and pulverulent. Colour various shades of green, but on exposure to the air becomes yellowish. Translucent. Lustre vitreous both on the surface and internally. Streak white. Taste astringent. Cleavage perfect parallel to *b*, less so to *f*. Fracture conchoidal. Consists of oxide of iron 25·7, sulphuric acid 28·9, water 25·4.—Berzelius. It is easily soluble in double its weight of water, and the solution turns black on being mixed with tincture of galls. If exposed to the air, it soon becomes covered with a yellow powder, which is the persulphate of iron. Before the blowpipe it becomes magnetic, and colours glass of borax green.



## OBSERVATIONS.

The green vitriol salt is usually produced by the decomposition of iron-pyrites, which, upon being exposed for some time in heaps to the atmosphere, and occasionally watered, affords it in considerable quantity. The old mine of Rammelsberg, near Goslar in the Hartz, is its most noted locality : it has also been found in aluminous shale at Hurlet near Paisley, at Gieshübl near Bodenmais in Bavaria, and in several of the Saxon and Hungarian mines. It is used in dyeing, in making sulphuric acid, ink, and Prussian-blue : and the residue from the distillation (the colcothar of iron) is employed as a red pigment, and for polishing steel.

## BLUE VITRIOL.

Tetarto-prismatic Vitriol Salt, *M.* Prismatic Vitriol, or Blue Vitriol, *J.* Sulphate of Copper, *P.* Kupfer Vitriol, *L.* Cuivre Sulfaté, *H.*

Sp. Gr. 2·213. *H.* = 2·5.

Tetarto-prismatic. FIG. 28.  $P$  to  $M = 109^{\circ} 32'$ ;  $P$  to  $T = 128^{\circ} 27'$ ;  $M$  to  $T = 149^{\circ} 2'$ . Occurs massive, pulverulent, and stalactitic ; rarely crystallized in its natural state. *Colour* generally dark sky-blue. *Translucent.* *Lustre* vitreous. *Streak* white. *Taste* astringent and metallic. *Cleavage* imperfect. *Fracture* conchoidal. Sulphate of copper consists, according to Berzelius, of peroxide of copper 50·90, sulphuric acid 49·10, besides water of crystallization to the amount of 36 in 100 of the crystals. It is easily soluble in water, and affords a blue solution, into which, when a polished plate of iron is dipped, its surface becomes coated with a film of metallic copper.

## OBSERVATIONS.

This salt, like the green vitriol, is derived from the decomposition of other minerals, particularly of copper-pyrites, and is sometimes found in a state of solution in water issuing from mines, to which the name of *waters of cementation* has been applied. Its chief localities are the Rammelsberg mine near Goslar in the Hartz, Fahlun in Sweden, Neusohl in Hungary, Anglesea, and Wicklow. Before being used in the arts it requires purification, and is then employed in dyeing, in printing cotton and linen, &c.

## WHITE VITRIOL.

Prismatic Vitriol Salt, *M.* Pyramidal Vitriol, or White Vitriol, *J.* Sulphate of Zinc, *P.*  
Zinc Vitriol, *L.* Zinc Sulfaté, *H.*

Sp. Gr. 2.036.  $H. = 2.0-2.5.$

Prismatic. FIG. 29. Inclination of  $l$  to  $M = 129^\circ 2'$ ; of  $M$  to  $M = 90^\circ 42'$ ; seldom in distinct crystals. *Colour* white, with pale tinges of pink and blue. Transparent or translucent. *Lustre* vitreous. *Streak* white. *Taste* nauseous metallic. *Cleavage* perfect parallel to the face  $o$ . *Fracture* conchoidal. It contains oxide of zinc 27.5, oxide of manganese 0.5, sulphuric acid 20.0, water 50.0—Klaproth, its chemical formula corresponding to 27.67 oxide of zinc, 27.57 sulphuric acid, and 44.76 water. It is very easily soluble in water, and before the blowpipe froths, gives off its sulphuric acid, and covers the charcoal with a white coating.

## OBSERVATIONS.

Being found generally associated with blende, it is supposed to owe its existence to the decomposition of that mineral. It occurs at the Ramelsberg mine in the Hartz, at Schemnitz in Hungary, at Fahlun in Sweden, and at Holywell in Wales. It is presented sparingly by nature, but is often produced artificially, and is then employed in medicine and in dyeing: a fine white colour named *zinc white*, which is said to retain its purity longer than white lead, is also prepared from it.

## EPSOM SALT.

Prismatic Epsom Salt, *M.* and *J.* Sulphate of Magnesia, *P.* Natürlich Bitter Salz, *W.*  
Bittersalz, *L.* Magnésie Sulfatée, *H.*

Sp. Gr. 1.75.  $H. = 2.0-2.5.$

Prismatic. FIG. 30. Inclination of  $l$  to  $M = 129^\circ 3'$ ; of  $M$  to  $M = 90^\circ 38'$ . Most common in crystalline fibres and as efflorescences. *Colour* white. Translucent. *Lustre* vitreous. *Streak* white. *Taste* bitter and saline. *Fracture* conchoidal. Brittle. Contains water 51.43, sulphuric acid 32.57, magnesia 16.0.—Berzelius. It fuses easily before the blowpipe unless its water of crystallization has been driven off; and it is soluble in less than double its weight of cold water.



## OBSERVATIONS.

This salt forms the principal ingredient of several mineral waters, and is a product of the decomposition of certain rocks, upon the surface of which it presents itself in efflorescence. In the former state it is obtained at Epsom in Surrey ; hence its name : and in the latter it occurs in the old coal wastes or alum mines of Hurlet near Paisley, in the quicksilver mines of Idria in Carniola (where, as it generally appears in silky fibres, the miners give it the appellation of *hair salt*), in the gypsum quarries of Montmartre near Paris, in the salt mines of Salzburg, and in various other situations. Specimens exhibiting a beautiful fibrous texture have been obtained at Arragon in Spain, at Beynfeld near Schneeberg in Saxony, and in the Cordillera of St Juan in Chili. After purification it is employed in medicine ; but, for that purpose, it is chiefly obtained by the manufacturing chemists from magnesian limestone and other sources.

## ALUM.

Octahedral Alum Salt, *M.* Octahedral Alum, *J.* Alum, *P.* Alaun, *L.* Alumine Sulfatée, Alumine Sulfatée Alcaline, *H.*

Sp. Gr. 1·75. H. = 2·0—2·5.

*Tessular.* *Form* the octahedron ; though in general it occurs either in fibrous masses or as an efflorescence. *Colour* white. Transparent and translucent. *Streak* white. *Lustre* vitreous. *Taste* sweetish astringent. *Cleavage* parallel to the faces of the octahedron, though imperfect. *Fracture* conchoidal. *Surface* smooth. It consists, according to Gmelin, of alumina 10·8, potash 10·1, sulphuric acid 33·7, water 45·4.

It is soluble in from sixteen to twenty times its weight of cold, and in little more than its own weight of boiling water. On exposure to heat it melts in its water of crystallization, froths up in a remarkable manner, and is converted into a spongiform mass of anhydrous alum.

## OBSERVATIONS.

This salt occurs chiefly in efflorescence on aluminous minerals, as alum slate, alum stone, or clay slate, and in such situations its best-known localities are the vicinity of Christiania in Norway, Whitby in Yorkshire, and Hurlet near Paisley. It forms layers having a columnar structure and transparent appearance in the strata of brown coal at Tschermig in Bohemia, and has also been met with in the vicinity of some of the volcanos and solfataras, at Lipari, the island of Nevis, Trinidad, &c. Its uses are various, being employed in the manufacture of leather, paper, &c. ; also in medicine, in dyeing, and for preserving animal sub-

stances from putrefaction. Bakers, in order to give their bread a whiter colour, sometimes adulterate it with this substance; and tallow, when melted with a small proportion of it, is rendered harder.

### BORAX.

Prismatic Borax Salt, *M.* Prismatic Borax, *J.* Borate of Soda, *P.* Tinkal, *Haus.*  
 Boraxsaures Natron, *L.* Soude Boratée, *H.*

Sp. Gr. 1.7—1.8. H. = 2.0—2.5.

Hemi-prismatic. FIG. 31. Inclination of *o* to *o* =  $120^{\circ} 23'$ , of *r* to *r* over *M* =  $88^{\circ} 9'$ , of *M* to *T* =  $90^{\circ}$ , of *M* to *P* =  $106^{\circ} 6'$ . Colour white or grey. Translucent or opaque. Streak white. Lustre resinous. Taste feebly alkaline. Cleavage perfect parallel to *M*, less so to *r*. Fracture conchoidal. Consists of—

Soda	16.31
Boracic acid	36.59
Water	47.10.—Berzelius.

It is soluble in six parts of boiling water, and when in solution changes the blue colour of violets into green. It intumesces before the blowpipe, and then melts into a transparent vitreous globule, denominated the *glass* of borax.

#### OBSERVATIONS.

The chief locality of borax is Thibet, where it is found on the surface of the soil, in the vicinity and at the bottom of certain lakes. It is there collected, and sent to Europe in a crude state under the name of *Tinkal*, which, after being purified, constitutes the refined borax of commerce. It is mentioned likewise from the mines of Potosi in Peru. It is made use of as a flux in several metallurgical processes, is sometimes employed with advantage in glass manufactories, and is highly valuable in aiding the operation of soldering.

### GLAUBERITE.

Hemi-prismatic Brythyne Salt, *Haid.* Glauberite, *J. P.* Brogniartin, *L.* Glauberite, *H.*  
 Anhydrous Sulphate of Soda and Lime, *Cleaveland.*

Sp. Gr. 2.75—2.85. H. = 2.5—3.0.

Hemi-prismatic. In oblique and extremely flat rhombic prisms. FIG. 32. Inclination of *f* to *f* =  $116^{\circ} 20'$ . Colour pale yellow, or grey. Semi-transparent. Lustre vitreous. Streak white. Taste slightly saline. Cleavage perfect parallel to the face *P*. Fracture conchoidal. Brittle. Contains

Sulphate of lime	49.0
Sulphate of soda	51.0 Brogniart,



its chemical composition being, according to Berzelius, 22·36 soda, 20·35 lime, and 57·39 sulphuric acid; that is to say, one atom of anhydrous sulphate of lime, and one atom of anhydrous sulphate of soda. When immersed in water it loses its transparency, and is partly dissolved. It attracts moisture, and falls to pieces when long exposed. Before the blowpipe it decrepitates, and melts into a white enamel; and, when rubbed and insulated, exhibits resinous electricity.

## OBSERVATIONS.

It occurs in embedded crystals in rock salt, at Villa Rubia, near Ocana in New Castile; also at Aussee in Upper Austria. Its optical properties, according to Sir David Brewster, are very peculiar, the structure being different from that of any other known species.

## POLYHALITE.

Polyhalite, *P.* and *L.* Haidinger in Brewster's Journal, VII. 246.

Sp. Gr. 2·77—2·78. H. = 2·5—3·0.

Prismatic. FIG. 33. Inclination of the adjacent faces *o* to *o* about 115°. Commonly in fibrous masses accompanying rock salt. Colour flesh-red or brick-red, sometimes inclining to yellow. Almost opake. Resinous, or with a slightly pearly lustre. *Streak* red. *Taste* bitter and astringent, but very faint. Analysis by Stromeyer:—Sulphate of lime with water 28·25, anhydrous sulphate of lime 22·42, anhydrous sulphate of magnesia 20·03, sulphate of potash 27·70, muriate of soda 0·19, red oxide of iron 0·34.

When presented to the flame of a candle it immediately becomes an opake mass of a brownish colour, and melts instantaneously under the blowpipe. It is slightly acted upon by a moist atmosphere, but its solubility in water is very inconsiderable.

## OBSERVATIONS.

Traces of crystallization have been observed as above, but in general this mineral occurs in fibrous and foliated masses along with rock salt, in the mines of Ischl and Aussee in Salzburg, and at Hall in the Tyrol. Its name is derived from *πολύς*, *many*, and *ἅλς*, *salt*, in allusion to the variety of its saline constituents. As yet it has not been applied to any useful purpose.

The *Bloedit* described by John, from Ischl, possesses almost the same properties as the above, and is probably only an impure variety of the same. *Vide* Mohs, III. 79.

## MASCAGNINE.

Mascagnine, or Sulphate of Ammonia, *J.* Sulphate of Ammonia, *P.* Maskagnin, *L.* Ammoniaque Sulphatée, *H.*

FIG. 29. *Form* similar to that of the white vitriol; generally stalactitic, pulverulent, or in mealy efflorescences. *Colour* grey or lemon-yellow. *Translucent* or opaque. *Streak* white. *Taste* pungent and bitter. Soluble in double its weight of water: attracts moisture from the atmosphere, and is entirely volatile in a higher temperature. It contains ammonia 22.80, sulphuric acid 53.29, water 23.91.—Gmelin.

## OBSERVATIONS.

This salt is found in the fissures of the earth and the lavas round volcanos, as at Ætna, Vesuvius, the Lipari Isles, and in the *lagune* near Sienna in Tuscany. It is frequently associated with sulphur.

## BOTRYOGENE.

Native Red Iron Vitriol of Fahlun, *Haid.* Brewster's Journ. IX. 48.

Sp. Gr. 2.039.  $H. = 2.25 - 2.5$ .

FIG. 34. Inclination of  $f$  to  $f = 81^\circ 44'$ , of  $q$  to  $q = 141^\circ 0'$ , of  $g$  to  $g = 119^\circ 56'$ . Faces of  $f$  and  $g$  striated parallel to the axis, and less perfectly formed than the inclined faces. In small crystals usually aggregated in reniform and botryoidal shapes, consisting of globules with a crystalline surface; sometimes like a bunch of grapes, and hence its name from *βοτρυς*. *Colour* deep hyacinth-red, which in compound massive varieties passes into ochre-yellow, the colour of its streak. *Translucent*. *Lustre* vitreous. *Sectile*, and a little shining in the streak. *Taste* slightly astringent. *Cleavage* parallel to the faces  $g$ . When exposed to a moist atmosphere it becomes covered with a dirty yellowish powder, but remains unchanged when dry. Before the blowpipe it intumescs and gives off water, leaving a reddish-yellow earth, which, according to the flame employed, may be changed into protoxide or peroxide of iron. With salt of phosphorus it yields a red glass, which loses its colour on cooling. Boiling water dissolves only part of it; the residue, which is a yellow ochre, is therefore not an integral portion of the mixture. When nitric acid is added to the solution, it may be precipitated by muriate of barytes. Ammonia takes away all the acid, and leaves the iron in the shape of a slightly greenish-black powder, so that the



iron contained in the salt is not a pure oxide, but a compound of the protoxide and peroxide.

## OBSERVATIONS.

It occurs in the great copper mine at Fahlun in Sweden, in the level called Mallanrumsort, forming a coating on gypsum or pyrites, along with Epsom salt, green vitriol, &c.

## MISY.

Occurs in pulverulent masses of a sulphur or lemon-yellow colour. Opake. Is a compound of sulphuric acid and iron, in different proportions however from the green vitriol; or, according to Berzelius, it is the persulphate of iron with excess of base.

## OBSERVATIONS.

Misy is a name applied by Pliny to some artificial compound obtained in the process of making vitriol in the island of Cyprus, and given by Hausmann to this substance. It occurs principally at Goslar in the Hartz; but is also met with accompanying the foregoing species at Fahlun in Sweden. The *Atrament stone* is another curious compound of sulphuric acid and iron. It is a mixture of the sulphate and peroxide of iron; is compact, ponderous, and of a dark brick-red colour; and is found accompanying the present species in the deserted parts of the copper mines of Goslar.

## NITRATE OF SODA.

Nitrate of Soda, *P.* Soude Nitratée, *H.*

Sp. Gr. 2.1.  $H. = 1.5-2.0$ .

Rhombohedral. *Form* a rhomb of  $106^{\circ} 33'$ , though generally met with as an efflorescence, or intermixed with clay and sand. *Colour* white. *Transparent*. *Lustre* vitreous. *Streak* white. *Taste* cooling and bitter. *Cleavage* perfect parallel to the faces of the rhomb. *Surface* smooth. Melts and deflagrates on heated charcoal, and is soluble in three times its weight of cold water. It

consists of Nitric acid	54.97	62.8
Soda	45.03	37.2.—Gmelin.

## OBSERVATIONS.

It occurs in immense quantities in the district of Tarapaca in Peru, near the frontiers of Chili, and is there collected for the manufacture of nitric acid and saltpetre. It forms a bed several feet thick, which in some places appears at the surface, and which occupies an extent of more than forty leagues. (*Phil. Jour.* vii. 184.) It is likewise met with at Fiume in Sicily; and is distinguished from nitre by its greater solubility in water, and its easier deliquescence on exposure to the air.

## SULPHATE OF COBALT.

Red Vitriol or Sulphate of Cobalt, *J.* Kobalt Vitriol, *W.*

Hemi-prismatic. FIG. 27. *Form* similar to that of the green vitriol. Occurs investing other minerals, in small masses, or in stalactites. *Colour* rose-red. Translucent or opaque. *Lustre* pearly. *Taste* astringent. *Streak* yellowish. *Surface* rough and longitudinally furrowed. Friable. Consists of oxide of cobalt 38·71, sulphuric acid 19·74, water 41·55.—Koppe. It is soluble in water, and communicates a blue colour to glass of borax.

## OBSERVATIONS.

It has been found at Leogang in Salzburg, and among the mine-heaps of Bieber in the neighbourhood of Hanau.

## SULPHATE OF POTASH.

Potasse Sulphatée,

Sp. Gr. 1·73. H. = 2·5—3·0.

Prismatic. FIG. 35. Inclination of the edge  $x$  to that on the opposite side of the crystal =  $120^{\circ} 29'$ ; of  $P$  to  $P = 112^{\circ} 32'$ ; of  $d$  to  $d = 112^{\circ} 8'$ . *Colour* white or yellowish, sometimes tinged green or blue superficially. Transparent or translucent. *Lustre* vitreous, inclining to resinous. *Streak* white, a little shining. *Taste* saline and bitter. *Cleavage* and *fracture* indistinct. It consists of sulphuric acid 45·93, and potash 54·07. Its crystals decrepitate when heated, and fuse at an increased temperature. They require sixteen times their weight of cold, and five times that of boiling water for solution; but as they do not contain any water of crystallization, no change is produced by exposure to air.

## OBSERVATIONS.

It has hitherto been met with only in a state of sublimation round the *fumaroles* of volcanos, and particularly at Vesuvius.

## TRONA.

*Haidinger*, in Brewster's Journal, II. 525. Striated Soda. *Klapr.* ii. 62.

Sp. Gr. 2·112. H. = 2·5—2·75.

Hemi-prismatic. FIG. 36. Inclination of  $n$  to  $n = 132^{\circ} 30'$ ; of  $M$  to  $T = 103^{\circ} 15'$ ; of  $n$  to  $T = 103^{\circ} 45'$ . Seldom in distinct



crystals. *Colour* white, inclining to yellowish-grey when impure. *Transparent* when in minute crystals, translucent in large masses. *Streak* white. *Taste* pungent, alkaline. *Cleavage* highly perfect, and easily obtained parallel to *M*. *Fracture* uneven. *Surface* of *n* and *M* smooth, of *T* generally striated horizontally. Rather brittle.

	Fezzan.	Maracaibo.
It contains, Soda	37·00	41·22
Carbonic acid	38·00	39·00
Water	22·50	18·00
Sulphate of soda	2·50.—Klap.	0·00.—Rivero.

Dr Henry found in 100 parts of the *urao* from South America, only 1·8 insoluble matter. Excluding this, the pure soluble portion contained 40 carbonic acid, 38 soda, 22 water, with a slight trace of muriate of soda, but no sulphate.

## OBSERVATIONS.

This substance has constantly been included by mineralogists with natron salt. It however obviously differs from that species, not only in crystalline form, but in its higher specific gravity and hardness, in its being much more difficultly soluble in water, and in the taste being less intensely alkaline. Neither does it give off its water of crystallization when exposed to the air, as natron salt does; and it may be preserved for any length of time unchanged in a dry atmosphere. It differs also in chemical composition, the Natron consisting of 1 atom of oxide + 1 atom of acid, while the Trona is constituted of three atoms of acid + 2 atoms of the base. It occurs in the province of Sukena, two days journey from Fezzan in Africa. It there forms a thin stratum in contact, both above and below, with muriate of soda; and is annually collected for exportation to the amount of some hundred tons. Trona is its African name; in the province of Maracaibo in South America, where it is found associated with the following species, it is called *urao*.

## GAY-LUSSITE.

Gay-lussite, *Cordier*. Phillips in Ann. of Phil. for April 1827. Boussingault in Ann. de Chimie, vol. XXXI.

Sp. Gr.=1·92—1·99. H. 2·0—3·0.

It occurs in detached and aggregated crystals, disseminated in clay. The less perfect of them might readily be mistaken for selenite; the more perfect and smooth have rather the aspect of calcareous spar. The latter are yellowish-white and translucent,

are doubly refractive in a high degree, extremely brittle, easily reduced to a grey powder, and do not phosphoresce either by friction or by heat. *Surfaces* channelled. *Fracture* conchoidal, with a vitreous lustre.

It appears to be a hydrous carbonate of lime and soda, consisting, according to Boussingault, of carbonate of soda 33.96, carbonate of lime 31.39, water 32.20, carbonic acid 1.45, alumine 1.00. When heated in a matrass, it decrepitates slightly and becomes opaque, decrepitation continuing until it has acquired a red heat. If then exposed to the flame of a blowpipe, it melts rapidly into an opaque globule, which when once formed is infusible, and has a decidedly alkaline taste. It dissolves with a brisk effervescence in nitric acid, and if the solution be then left to spontaneous evaporation, fine crystals of nitrate of soda are formed, floating in a solution of nitrate of lime. It is partially soluble in water, yielding a solution which reddens turmeric paper, and is precipitated by oxalic acid.

## OBSERVATIONS.

This mineral is found abundantly at Lagunilla, near Merida in Maracaibo. It occurs disseminated at the bottom of a small lake, in a bed of clay, covering Trona, which the natives term *Urao*, in contradistinction to the Gay-lussite; the latter, from its generally elongated form, being called *Clavos* or nails. It was named in honour of the celebrated French chemist Gay-Lussac.

## OXALATE OF IRON.

Fer Oxalaté, *Levy*.

Sp. Gr. 2.13.

Earthy, crystalline form undetermined. *Colour* yellow. *Opake*. Without lustre. *Fracture* uneven, earthy.

Contains Protoxide of iron 53.86

Oxalic acid . . . 46.14 Rivero.

It is insoluble in water and alcohol, but dissolves without effervescence in nitric acid, imparting to it at same time a yellowish tint. In the flame of a candle it blackens immediately, and then acts upon the magnetic needle. It occurs at Koloseruk in Bohemia.



## ORDER HALOIDE.\*

### GYPSUM.

Prismatoidal Gypsum Haloide, *M.* Prismatoidal Gypsum, *J.* Gypsum, Sulphate of Lime, *P.* Gyps. Fraucneis, *W.* and *Haus.* Wasserhaltiger Schwefelsaurer Kalk, *L.* Chaux Sulfatée, *H.*

Sp. Gr. 2·31. H. = 1·5—2·0.

Hemi-prismatic. FIG. 37. Inclination of  $l$  to  $l = 142^{\circ} 52'$ , of  $f$  to  $f = 110^{\circ} 37'$ . Colour generally white, sometimes yellow, and, according as it is mixed with impurities, red, grey, and brown. Transparent or translucent. Lustre vitreous, and sometimes pearly. Streak white. Is easily scratched with the nail. Cleavage in thin laminæ parallel to  $P$ , which are flexible but not elastic. It consists of, lime 33·0, sulphuric acid 44·8, water 21·0.—Bucholz. Before the blowpipe it exfoliates, and melts though with difficulty into a white enamel, which, after a short time, falls into powder. In a lower degree of heat it loses its water of crystallization, and becomes friable, so as to be easily reduced to an impalpable powder, which, if mixed with water, becomes warm, and speedily hardens into a solid mass, forming plaster of Paris. When pure it does not effervesce with acids.

#### OBSERVATIONS.

The name of *Selenite* has been very commonly applied to the clear transparent crystals of this beautiful mineral, and of these the finest specimens are found in the salt mines of Bex in Switzerland, at Hall in the Tyrol, in the sulphur mines of Sicily, in the gypsum formation near Ocana in Spain, and among the clay of Shotover Hill near Oxford, where they generally occur detached and perfectly symmetrical. Large lenticular crystals, and the scaly varieties, are found at Montmartre near Paris; and some interesting specimens, with the laminæ diverging from the obtuse angle of the crystals, have latterly been met with at Lindorf near Bonn, on the Rhine. It also occurs in acicular crystals in the cavities of lava. For the fibrous varieties, Derbyshire (and particularly Matlock) has long been celebrated; while the granular gypsum is of common occurrence in many countries. Large quar-

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\* Haloide, from ἅλς, salt, and εἶδος, form.

ries of a pure white variety have lately been opened near Cavalese in the Val de Lavis, Southern Tyrol. Similar quarries are worked at Vizille, to the southward of Grenoble in France. At Luneburg it forms the matrix of the boracite, and, though there of a grey colour, is also worked for making stucco. Near Sienna in Tuscany it occurs extremely pure and compact, and is thence conveyed in large blocks to Florence, where it is wrought upon the lathe into those beautiful alabaster figures and vases so common on our chimney-pieces. The nucleus employed in the manufacture of Roman pearls is from the same locality. Whole ranges of hills in Suabia, Thuringia, Bologna, and other parts of the continent, are formed of massive gypsum; and many interesting organic remains of fish and quadrupeds have in different places been found imbedded in it. A coating of gypsum is known to form itself, combined with ferruginous matter and carbonate of lime, sometimes to the thickness of more than an inch, on the surface of engine boilers, to their great detriment; and on these deposits the regular crystals of gypsum are often recognisable.

This species is variously employed in manufacturing artificial marbles, the Scagliola tables of Leghorn, for instance; also in sculpture, for making casts of statues, medals, &c., for which purpose it is previously, by calcination and grinding, reduced to a white powder commonly known as plaster of Paris, or stucco. It is added to the mass of certain kinds of glass and porcelain, and is used in agriculture for improving meadow-grass. In Derbyshire a good many hands are employed in the turning and manufacture of alabaster cups and vases, which, though not to be compared with those of Florence, are notwithstanding often very handsome. The fibrous variety, when cut *en cabachon* and polished, reflects a light similar to cat's eye. In the form of beads it is frequently worn for necklaces. The most decided characteristic of crystallized gypsum is the flexibility of its laminae, into which it may be separated to almost any degree of thinness. The massive varieties are at once known from limestone and other similar minerals by their inferior hardness, being easily scratched with the nail, and yielding a white powder.

### ANHYDRITE.

Prismatic Gypsum Haloide, *M.* Prismatic Gypsum or Anhydrite, *J.* Anhydrous Gypsum, *P.* Wurfelspat, Muriazit, *W.* Karstenit, *Haus.* Wasserfreier Schwefelsaurer Kalk, *L.* Chaux Sulfatée Anhydre, *H.*

Sp. Gr. 2·7—3·0. H. = 3·0—3·5.

Prismatic. Occurs in rectangular four-sided prisms, in which the cleavage is obtainable in three directions perpendicular to each other, one of them less distinct than the other two. Colour generally white, sometimes slightly tinged blue or red. Lustre vitreous, inclining to pearly. Streak greyish-white. Fracture uneven, slightly conchoidal. Contains, lime 41·75, sulphuric



acid 55.0, muriate of soda 1.0—Klaproth, being a dry sulphate of lime, with a trace of sea salt. It differs from gypsum in not exfoliating before the blowpipe: it whitens, however, and becomes covered with a friable enamel.

## OBSERVATIONS.

The anhydrite has commonly received the name of *muriacite* or *vulpinite*, according as it occurs either in a crystalline or granular state. Of the first, fine specimens are found in the salt-mines of Bex in Switzerland, and at Hall in the Tyrol. In the old mines of Aussee it occurs both in fine cleavable varieties and in compact masses of a brick-red colour, imbedded along with gypsum and polyhalite in beds of rock salt. At Sultz on the Neckar, and at Bleiberg in Carinthia, it is often of a beautiful blue colour. Compact and columnar varieties occur accompanying the rock salt at Ischl in Upper Austria, and at Berchtesgaden in Bavaria: and the contorted species called *gekrosstein* or *pietre de trippes* has principally been found at Wieliczka and Bochnia in Poland. The *vulpinite* of Italy, called also marmo bardiglio di Bergamo, from Vulpino, near Bergamo, is cut and polished for ornamental purposes, but in general the anhydrite is not sufficiently compact to admit of this. It is distinguished from the preceding species by its superior hardness, and its cleavage.

## PHARMACOLITE.

Hemi-prismatic Euclase Haloide, *Haid.* Arseniate of Lime, *P.* Arsenic-bluthe, *Werner.*  
Chaux arseniatée, *H.* *Haidinger* in Brewster's Journ. vol. III. 502.

Sp. Gr. 2.64—2.8. H. = 2.0—2.5.

FIG. 38. Inclination of  $f$  to  $f = 117^\circ 24'$ , of  $o$  to the edge between  $f$  and  $f = 83^\circ 14'$ . Colour white or greyish, but often tinged red by the arseniate of cobalt, with which it is not unfrequently associated. Cleavage parallel to  $P$  highly perfect and easily obtained. Fracture uneven. Translucent or opaque. Lustre vitreous. Occurs in minute silky fibres or acicular crystals, aggregated in stellated or divergent groups; more rarely also in distinct crystals of considerable dimensions.\*

	Wittichen.	Andreasberg.
Consists of Lime	25.00	27.28
Arsenic acid	50.54	45.68
Water	24.46.—Klaproth.	23.86.—John.

\* I possess a specimen which was presented to my father by Mr Ferguson of Raith, having crystals of this description. It formed part of a collection which belonged to the Baron de Born, and was accompanied with a long description, which, however, indicated no locality.

Exposed to the blowpipe it is almost entirely volatilized, and gives off a dense white arsenical vapour. In nitric acid it dissolves readily without effervescence.

## OBSERVATIONS.

Clear transparent crystals of pharmacolite, very distinctly pronounced, and fully a line in diameter, were at one period found in the grand duchy of Baden, probably at Badenweiler; and of these, some fine specimens are preserved in the grand-ducal palace at Carlsruhe. It occurs in botryoidal or globular groups of minute silky white crystals at St Marie aux Mines in the Vosges, at Andreasberg in the Hartz, and at Riegelsdorf in Hessa; and in acicular fibres, accompanied with cobalt, and disseminated on granite, at Wittichen near Furstenberg, in Germany.

The *picro-pharmacolite* of Stromeyer, from Riegelsdorf in Hessa, contains about three per cent. of magnesia, but in other respects corresponds to the above description.

## HAIDINGERITE.

Diprismatic Euclas Haloide, *Haid.* Diatomous Gypsum Haloide. *Haidinger* in Brewster's Journal, vol. III. 303.

Sp. Gr. 2.84. H. = 2.0—2.5.

FIG. 39. Inclination of  $e$  to  $e = 100^\circ$ , of  $a$  to  $a$  over the terminal edge =  $126^\circ 58'$ . Colour white and transparent, with a vitreous *lustre* and white *streak*. Cleavage highly perfect and easily obtained parallel to  $d$ . According to Turner, it consists of arseniate of lime 85.68, water 14.32; and like the last species dissolves easily in nitric acid.

## OBSERVATIONS.

This mineral was first noticed by Mr Haidinger, accompanying the pharmacolite from Baden, of which it had previously been considered a variety. Its form and lustre, however, are so materially different, as to place its identity as a distinct species beyond a doubt. It is very rare.

## CRYOLITE.

Prismatic Cryone Haloide, *M.* Prismatic Cryolite, *J.* Cryolite, *P.* Kryolith, *L.* Alumine fluatée alcaline, *H.*

Sp. Gr. 2.96. H. = 2.5—3.0.

Prismatic. Massive. Colour snow white, but, when associated with iron, yellow and brown. Translucent, and, when immersed in water, almost transparent. Lustre vitreous. Streak



white. *Structure* lamellar. *Cleavage* in three directions perpendicular to each other, and two of them very perfect. Contains

Alumina	24·0	24·40
Soda	36·0	31·35

Fluoric acid 40·0 Vauquelin. 44·25 Berzelius.

It is very fusible, even when held in the flame of a taper. Before the blowpipe it is at first perfectly liquefied, then becomes hard, white, and opake, and ultimately assumes a slaggy appearance.

## OBSERVATIONS.

The only known locality of this mineral is Arksutfiord, West Greenland, where it was found by Giesèké in two small veins in gneiss accompanied by galena, iron pyrites, quartz, felspar, and carbonate of iron. From its comportment before the blowpipe it has obtained the name of cryolite, in allusion to its easy fusibility—like ice before a flame. Though insoluble, it receives a higher degree of transparency when immersed in water, and admits much more easily of cleavage after having been kept in it for some time. Previous to being brought to Europe by Giesèké this was an extremely rare mineral, but since that period pure white masses are to be met with in most of our collections. In that of my father there is one square mass nearly half a foot in diameter; and in the cabinets of Copenhagen they are sufficiently numerous.

## HOPEITE.

Brewster. Trans. Royal Soc. Edin. X. 107.

Sp. Gr. = 2·46—2·76. H. = 2·5—3·0.

Prismatic. FIG. 41. Inclination of  $M$  to  $M$  over  $g = 101^\circ 24'$ , of  $s$  to  $s$  over  $l = 81^\circ 34'$ . *Cleavage* perfect parallel to  $l$ . *Colour* greyish white. Transparent or translucent. *Lustre* vitreous, inclining to pearly on the face  $l$ . *Streak* white. Surface of  $p$  deeply streaked in a longitudinal direction; rest of the faces smooth. It is entirely soluble without effervescence in the muriatic and nitric acids; but is acted upon very slowly by sulphuric acid. It is neither phosphorescent nor electric by heat. According to Nerdenskiöld, its water is given off before the blowpipe, and it then melts into a clear colourless globule, which tinges the flame green. The melted mineral forms a fine blue glass with solution of cobalt; and, according to Brewster, "it is probably a compound of some of the stronger acids, as phosphoric or boracic acid, of zinc, an earthy base, a little cadmium, and a great deal of water."

## OBSERVATIONS.

This very rare substance was first noticed and described by Sir David Brewster, to whom it had been sent as a variety of stilbite, and who distinguished it by the name of Hopeite, in honour of the present professor of Chemistry in the University of Edinburgh. It has hitherto been found only in the calamine mines of Altenberg, near Aix-la-Chapelle.

## ALUM-STONE.

Rhombohedral Alum Haloide, *M.* Rhomboidal Alum Stone, *J.* Alum Stone, *P.* Alaunstein, *L.* Alumine sous-sulfatée alcaline, *H.*

Sp. Gr. 2·7. H. = 5·0.

Rhombohedral. FIG. 42. Inclination of P to P = 92° 50'. Crystals minute and transparent, generally occupying the cavities of massive alum-stone, which in most cases is coloured and opaque. *Colour* white, sometimes reddish or greyish. *Lustre* vitreous, inclining to pearly upon the more distinct faces of cleavage. *Streak* white. *Cleavage* parallel to the face *o*.

Mont d'Or in Auvergne. Tolfa.

Contains Sulphuric acid	27·05	25·00
Alumina	31·80	43·92
Potash	5·79	3·08
Silica	28·40	24·00
Water and loss	3·72 Cordier.	4·00 Vauquelin.

Before the blowpipe it decrepitates, and neither melts by itself nor with soda, but is fusible into a colourless globule with borax. When pounded it is soluble in sulphuric acid.

## OBSERVATIONS.

This mineral occurs well crystallized at Tolfa near Civita Vecchia in the Roman states, decomposed and friable at the isle of Nevis, and in the crater of Volcano, one of the Liparis. The compact varieties from Beregh in Hungary are so hard as to admit of being used for mill-stones. Pure alum is procured from this mineral by repeatedly roasting and lixiviating it; and from the solution thus obtained the crystalline salt is produced by evaporation.

## WAVELLITE.

Prismatic Wavelline Haloide, *Haid.* Sub-phosphate of Alumine, *P.*

Sp. Gr. = 2·337. H. = 3·5—4·0.

Prismatic. FIG. 43. Inclination of *o* to *o* = 107° 26', of *d* to *d* = 122° 15'. *Cleavage* perfect parallel both to the faces P and *d*.



*Colour* white, passing into various shades of yellow, green, grey, brown, and black. *Translucent*. *Lustre* vitreous. Consists of,

Alumina	37·20	35·35
Phosphoric acid	35·12	33·40
Water	28·0	26·80
Fluoric acid	00·0	2·06
Lime	00·0	0·50

Ox. of iron and man. 00·0 Fuchs. 1·25 Berzelius.

Before the blowpipe it loses its lustre and translucency, and becomes white, but does not melt. With boracic acid and iron wire it yields a globule of phosphuret of iron, and when reduced to powder it dissolves in heated nitric or sulphuric acid, giving off a vapour which slightly corrodes the glass.

## OBSERVATIONS.

It is extremely rare to find this substance so distinctly crystallized as to admit of measurement by the goniometer. Its usual mode of occurrence is either in botryoidal and globular concretions, or in delicate fibrous and radiated groups. It is found at Barnstaple in Devonshire, where it was first discovered by Dr Wavel in small veins in clay-slate; also in very highly coloured pistachio-green masses at Clonmell, and near Cork; in white stellated groups on red sandstone at Zbirow in Bohemia; on brown iron ore at Amberg in Bavaria (a variety to which Fuchs applied the name of *Lasionite*); in the Shaint isles of Scotland; and near Villa Rica in the Brazils.

## KAKOXENE.

*Steinmann*, in *Brewster's Journal*, V. 165.

In minute diverging fibrous groups radiating from a point. *Colour* brownish yellow. *Lustre* silky. It contains, according to *Steinmann*, silica 8·90, phosphoric acid 17·86, alumina 10·01, oxide of iron 36·32, lime 0·15, water and fluoric acid 25·09.

## OBSERVATIONS.

It occurs disposed on brown iron ore in the iron mines of Hrbeck near Zbirow in Bohemia, and might be readily mistaken for Karpbolite, which is found under similar circumstances, but for its deeper tinge. Its name is derived from *κακος*, *bad*, and *ξενος*, *a guest*, in allusion to the bad influence of the phosphoric acid it contains, on the quality of the iron extracted from the ore with which it occurs.

## FLUOR SPAR.

Octahedral Fluor Haloide, *M.* Octahedral Fluor, *J.* Fluor, Fluat of Lime, *P.* Fluss, *Haus.* Fluss-saurer Kalk, *L.* Chaux Fluatée, *H.*

Sp. Gr. 3·0—3·3. H. = 4·0.

**Tessular.** Most common form the cube. *Colour* extremely various, and of every degree of intensity. Translucent and transparent. *Lustre* vitreous. *Streak* white. *Cleavage* perfect, and easily obtained parallel to the faces of the octahedron. *Fracture* conchoidal. Consists of—

Lime	67·75	72·14
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Fluoric acid	32·25.—Klaproth.	27·86.—Berzelius.
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Before the blowpipe it decrepitates and becomes phosphorescent, but loses its colour and fuses into a rather opaque white globule. It phosphoresces likewise if, in the state of powder, it be thrown upon ignited charcoal or heated iron, and gives off fluoric acid when submitted to the action of sulphuric acid.

## OBSERVATIONS.

Fluor spar is one of the most beautiful species in the mineral kingdom in respect of the variety and splendour of its numerous colours and forms. It does not enter as a regular constituent into the composition of rocks, though it is very common in some countries, as in England; whilst in Scotland and Ireland few traces of it have hitherto appeared. The lead mines of Alston-Moor and Derbyshire have long been celebrated for their magnificent crystals of fluor spar. These in general take the form of the cube, and present the finest shades of blue and green, varying in colour as the light by which they are examined is reflected or transmitted. Small globules of liquid are at times observable in the green and blue varieties from Alston, and cubical crystals of the extraordinary size of six or seven inches have also been met with from that locality. Some beautiful octahedral forms occur at Beeralston in Devonshire, while the neighbouring county of Cornwall has afforded a greater variety of crystallizations than occur in any other quarter of England. Dark blue cubical crystals of fluor spar have been found in small geodes, along with quartz, in porphyritic greenstone, near Gourock in Renfrewshire, also in Aberdeenshire, but otherwise it is little known north of the Tweed. Well-defined octahedrons of an apple-green colour occur at Moldawa in the Bannat; rose-red crystals of the same form near Chamonix in Savoy, one of which, measuring fully two inches along its base, perfect in shape, and of the richest colour, is preserved in the Museum of Natural History at Geneva, and another in the collection of Mr Grimstone of Yorkshire; while the Saxon varieties are generally in the form of the cube having



its angles variously modified, and present either violet-blue or wine-yellow colours. Many beautifully crystallized specimens occur in the Brisgau. Compact varieties are mostly brought from Sweden and Cornwall; also from Stolberg in the Hartz, where it presents a fine sky-blue colour when raised from the mines, and shortly, on exposure, becomes perfectly white. Earthy fluor occurs in Saxony, and in the counties of Durham and Derby, either in the state of powder, or exhibiting a friable texture. The name *chlorophane* has been applied to those varieties (and particularly to that from Nertschinsky in Siberia), which, when exposed to heat, exhibit the phenomenon of phosphorescence in peculiarly bright-green colours. This property they will show repeatedly, if not exposed to too high a temperature; and one of the best modes of exhibiting it is by immersing the specimen in hot water. When the powder of this mineral is thrown into sulphuric acid, it is immediately decomposed, the lime forming with it gypsum, while the fluoric acid is disengaged. Etchings on glass are sometimes executed, by exposing a plate partially coated with wax, to the action of this acid as it is thus evolved in a gaseous state: that portion of the glass covered by the wax of course remains entire, while whatever has been laid bare will shortly be found to have been acted upon to a considerable depth, and thus figures of any description may be produced on glass without much difficulty. In the vicinity of Castleton in Derbyshire it is found in large crystalline masses, generally presenting a concentric arrangement of various colours, but usually of a rich translucent deep blue, and hence it is familiarly known by the name of *Blue John*. After certain preparations for the purpose of increasing its tenacity, this variety admits of being wrought on the lathe, and is turned into vases and other articles of ornament; some of these have a red tinge, which is produced by exposure to heat. Its most important employment, however, is that of fluxing the metallic ores, and particularly those of iron and copper; hence its name, from the Latin *fluo*, to flow.

## APATITE.

Rhombohedral Fluor Haloide, *M.* Rhombohedral Apatite, *J.* Apatite, Phosphate of Lime, *P.* Spargelstein, Phosphorit, *W.* Phosphorsaurer Kalk, *L.* Chaux phosphatée, *H.*

Sp. Gr. 3.0—3.3. H. = 5.0.

Rhombohedral. FIG. 44. Inclination of  $x$  to  $x = 142^\circ 20'$ , of  $x$  to  $x$  over  $M = 80^\circ 25'$ . Colour various, sometimes even in the same crystal, but principally green, grey, or blue, and seldom bright, varying from clear and transparent, to perfectly opaque. Lustre vitreous, inclining to resinous. Streak white. Cleavage imperfect parallel both to the lateral and terminal planes of the prism. Fracture conchoidal and uneven.

	Phosphorite.	Asparagus stone.
Consists of Lime	59·0	55·75
Phosphoric acid	34·0	44·25
Carbonic acid	1·0	0·00
Fluoric acid	2·5	0·00
Silica	2·0	0·00
Oxide of iron	1·0 Pelletier.	0·00 Klaproth.

It is slowly soluble in nitric acid, and without effervescence. Some varieties are phosphorescent upon ignited charcoal and before the blowpipe ; others become electric by heating, or even on being rubbed. In a very high temperature the edges and angles are rounded off, but it does not melt without addition. With salt of phosphorus it affords a clear globule.

## OBSERVATIONS.

The phosphate of lime has generally been distinguished into phosphorite and apatite, according as it occurs in a massive or crystalline state. Of the latter, the finest specimens are found at Ehrenfriedersdorf in Saxony, and Schlackenwald in Bohemia. Beautiful crystals have also been discovered at Caldbeck Fell in Cumberland, in Devonshire, and in Cornwall ; while those from St Gothard in Switzerland are remarkable for their whiteness and transparency, and the beauty and regularity of their complex forms. The variety called *moroxite*, from Arendal in Norway, is opaque, and of a greenish-blue colour ; that termed *asparagus stone*, or *spargelstein*, from the Zillertal in the Tyrol, is translucent, of a wine-yellow hue, and imbedded in green talc ; while the *phosphorite* or massive varieties are mostly derived from Estremadura in Spain, and Schlackenwald in Bohemia. In the British Museum there is one hexagonal prism of apatite of a pale amethyst colour, said to be from the neighbourhood of St Petersburg, which cost the late Mr Greville L.78 sterling.

Some of the Saxon varieties not unfrequently present different colours in the same crystal. There is one, for instance, in the possession of Mr Heyer of Dresden, a large distinct prism, which has five bands or rings crossing the axis, those at the extremities being white, the middle one red, and the two intervening of a pale-green tint. It was named apatite by Werner, from *απαταω*, to deceive, in consequence of the deception it so long caused to the older mineralogists. Rose has found some varieties of it to contain several per cent. of the chloride and the fluoride of calcium.



## HERDERITE.

Prismatic Fluor Haloide, *Haid.* Brewster's Journal, IX. 360.

Sp. Gr. 2.9—3.1. H. = 5.0.

FIG. 45. Inclination of  $p$  to  $p$  over the edge =  $77^{\circ} 20'$ , of  $p$  to  $p$  contiguous =  $144^{\circ} 16'$ , of  $t$  to  $t$  contiguous =  $64^{\circ} 51'$ .

*Colour* several shades of yellowish and greenish white, strongly translucent. *Lustre* vitreous, inclining to resinous. *Streak* white. Very brittle. *Cleavage* interrupted parallel to M. *Fracture* small conchoidal. Surface of M very smooth and delicately streaked parallel to its edges of combination with P.

## OBSERVATIONS.

Herderite occurs, imbedded in fluor, in the tin mines of Ehrenfriedersdorf in Saxony. It much resembles asparagus stone, and was considered, like that mineral, a variety of apatite, until examined by Haidinger, who distinguished it as a particular species under the above name, in compliment to Baron von Herder, the director of the Saxon mines. The only specimen of it at present known, and on which the above observations were made, is preserved in the Wernerian Collection at Freyberg.

## SCORODITE.

Dystomic Fluor Haloide, *Haid.* Skorodite, *J.* Martial Arseniate of Copper, *P.* Skorodit, *Breit.*

Sp. Gr. 3.1—3.2. H. = 3.5—4.0.

Prismatic. FIG. 46. Inclination of P to P over the edge =  $115^{\circ} 6'$ , of P to P contiguous =  $102^{\circ} 1'$ , of  $d$  to  $d$  over the face  $r$  =  $119^{\circ} 2'$ . *Colour* principally pale leek green, or liver brown. Semi-transparent. *Lustre* vitreous, inclining to adamantine on the surface. *Streak* white. *Cleavage* imperfect. *Fracture* uneven.

Chenevix found the Cornish variety to consist of oxide of copper 22.5, arsenic acid 33.5, oxide of iron 27.5, water 20.0, silica 3.0. Before the blowpipe it emits an arsenical odour, and fuses into a reddish-brown scoria, which acts upon the magnet if heated long enough to drive off the arsenic.

## OBSERVATIONS.

Bournon's cupreous arseniate of iron, and the Cornish martial arseniate of copper, are both merely varieties of this mineral. The brown coloured scorodite is from Schwarzenberg, in Saxony; while the fine leek-green

crystals are found in the Cornish mines, coating cavities of ferruginous quartz. Beautiful specimens have latterly been brought from Minas Geraes, in Brazil.

### ARAGONITE.

Prismatic Lime Haloide, *M.* Prismatic Limestone or Arragonite, *J.* Arragonite, *P.* Eisenbluthe, *W.* Arragon, *L.* Arragonite, *H.*

Sp. Gr. 2·6—3·0. H. = 3·5—4·0.

**Prismatic.** FIG. 47. Inclination of P to P =  $108^{\circ} 8'$ , of M to M =  $116^{\circ} 6'$ . Its most prevalent colour is white, though sometimes tinged yellow, green, and blue. Transparent and translucent. *Lustre* vitreous, inclining to resinous. *Streak* greyish white. *Cleavage* distinct, parallel to the faces of a six-sided prism. *Fracture* conchoidal, uneven. It generally contains traces of carbonate of strontites, sometimes amounting to five or six per cent.; but it indicates no constant proportion, and is often (particularly the coralloidal varieties) entirely free from it. According to two analyses by Stromeyer, it contains

Carbonate of lime	94·82	99·29
Carbonate of strontites	4·08	0·51
Water	0·98	0·15

Thin fragments of transparent crystals decrepitate in the flame of a candle. Other varieties lose their transparency, and become friable. It phosphoresces upon red hot iron, and is soluble in nitric and muriatic acids, during which process the carbonic acid is disengaged.

### OBSERVATIONS.

This mineral takes its name from the province of Aragon in Spain, where it was first discovered in large detached twin crystals, imbedded in a ferruginous clay, and accompanied by gypsum. The most beautiful, well-defined, and transparent individuals, have since been found near Bilin, in Bohemia, in a vein traversing basalt; but these are also macled. At first sight they might be taken for regular six-sided prisms; but on close inspection a longitudinal crack will be observed down each lateral face, at the junction of the different individuals. The branching or coralloidal varieties, to which the name of *Flosferri* has been given, occur in beds of iron ore, and are particularly beautiful in the Styrian mines of Eisenerz, where they present themselves coating the surface of cavities, and even caves of considerable extent. The formation of these is considered to be intimately connected with the decomposition



of the sparry iron which accompanies them. The massive, silky, and fibrous variety so well known, when polished, under the title of *Satin spar*, which occurs at Dufton, is found traversing shale in thin veins, generally accompanied with iron-pyrites. This delicate variety sometimes presents a beautiful rose-coloured tinge; but it is not common. Aragonite also occurs in caverns, stalactitically disposed on the roofs and sides, as in the caves along the coast of Galloway, in Buckinghamshire, Devonshire, &c. Many fine stalactitic specimens of a snowy whiteness have been met with at Leadhills in Lanarkshire, and even in the recent formations of volcanic mountains; among the lavas of Vesuvius, for instance, it occurs in radiated and acicular minute white crystals.

Aragonite may with facility be distinguished from calcareous spar, by exposing it to heat, before which it at once flies into powder, while the calcareous spar placed along side of it remains unchanged, and even retains its transparency. Its cleavage in a longitudinal direction should also be a sufficient characteristic; the faces of cleavage in calc spar, however small the individuals, being always inclined.

#### CALCAREOUS SPAR.

Rhombohedral Lime Haloide, *M.* Limestone, *J.* Carbonate of Lime, Marl, *P.* Bergmilch, Kalkstein, Kalktuff, Kalkspath, Kreide, Stinkstein, Mergel, Duttenstein, Shieferspath, Anthracolith, Anthraconit, Kohlensaurer Kalk, *of the Germans.* Chaux Carbonatée, *H.*

Sp. Gr. 2.5—2.8. H. = 3.0.

Rhombohedral. FIG. 1. Much the most prevalent colour, white; also of a great many different shades of yellow, green, blue, and red, most of them pale; dark brown and black colours owing to foreign admixtures. Transparent or translucent. Double refraction in the transparent specimens very distinct. *Lustre* vitreous. *Streak* impure white. Primary form the rhomb of  $105^{\circ} 5'$  and  $74^{\circ} 55'$ , which it always presents on cleavage. The pure varieties consist of

Lime	56.15	55.50	56.33
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Carbonic acid	43.70	Strom.	44.00	Phillips.	43.05	Biot.
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But the coloured ones not unfrequently contain small portions of oxide of iron, silica, magnesia, alumina, carbon, or bitumen. It effervesces violently with acids; and, if pure, is entirely soluble in the nitric. At an ordinary heat it is infusible, but loses its carbonic acid, shines with a peculiar brightness, and ultimately becomes quicklime.

## OBSERVATIONS.

There are few substances in the mineral kingdom more common than calcareous spar, and certainly none which presents a greater variety of crystalline form. Among its most distinguished localities may be enumerated Andreasberg, and other mining districts in the Hartz, where the six-sided prisms, and cannon-shaped varieties as they are termed in that part of Germany, have been found in great beauty; Alston Moor, in Cumberland, which affords the flat rhombic crystals; and Derbyshire, whence the pale yellow transparent pyramids, sometimes of very large dimensions, are obtained. It would be endless to particularize the localities of this mineral; it occurs in almost every country where rocks are to be found, and, under such an infinity of forms and appearances, the enumeration of even the more remarkable would be tedious. Under the head of calcareous spar, however, the older mineralogists placed a number of subspecies, which depend chiefly upon their mode of composition, and upon admixtures and impurities with which the individuals have been effected at their formation. Of these it may be well briefly to notice the following:—

*Iceland Spar*, or double refracting spar as it is appropriately called, from its remarkable property of double refraction, a property which was described by Erasmus Bartholinus so early as the year 1670. It is in general perfectly limpid, and breaks into the most beautiful rhombs. It is not found in regular crystals, although the surface of the masses indicate crystallization, and are often implanted with stilbite and heulandite. It is found only on the eastern coast of Iceland.

*Stalactitic Carbonate of Lime*, which occurs mamillated, or in long pendulous masses or tubes coating the interior of caves. Though deposited from water loaded with particles of lime, and therefore in a constant state of formation, these stalactites, which outside are commonly of a yellowish-white colour, and present an infinity of different shapes and sizes, invariably afford the most distinct cleavage, perfect rhombs being easily produced from any portion of them. Properly speaking, the pendulous masses only are *stalactites*: such as form on the bottom of the caverns by deposition from the roof, and therefore, as it were, grow up until by degrees they meet those which are pendent, are known under the appellation of *stalagmites*. The extensive caverns of Adelsberg in Carniola derive the magnificence and splendour of their natural architecture from the thousands of these stalactites with which they are ornamented in the shape of festoons, curtains, foliage, and other fantastical and extraordinary forms. These caverns constitute a labyrinth of many miles within porous limestone rocks, and as yet but a small portion of them has been explored. The cave of Macallister, in the Isle of Skye, is another of the same description, though much inferior in extent and beauty to those of Carniola. The substance properly termed *Alabaster* is this same mineral in a massive state, when it is commonly employed in the formation



of vases and statuary. The oriental alabaster was much prized by the ancients for such purposes.

*Shiefer Spar* or *Slate Spar*, so called in allusion to its slaty structure, occurs massive, and in extremely thin tabular plates intersecting each other in various directions, but without any determinate crystalline form. It is usually white, with a shining pearly lustre, soft, easily frangible, and rather greasy to the touch. It is in fact a lamellar carbonate of lime, and is found principally in the county of Wicklow, in Glentilt Perthshire, and in metalliferous beds in Norway. Between the shiefer spar and the *aphrite* there is scarcely any transition, the latter being also a variety of nearly pure carbonate of lime, and consisting of pearly white scales, which have a shining lustre, and are soft and friable to the touch. It differs principally in being less coherent; and is met with only in Hessa and Thuringia.

*Oolite*, or *Roestone* as it is called, from the resemblance between the little round masses of which it is composed and the roe of a fish, occurs massive and in beds. The globular particles are formed of concentric laminae, and usually adhere by means of a calcareous cement. It is an impure carbonate of lime, and will not burn into quicklime; is very soft when first quarried, but hardens on exposure, and in colour is white, yellowish-white, or grey. The Portland and Bath stones are varieties of this, and in many parts of the south of England its properties are well known as a building material. Both St Paul's and Somerset House are composed of it.

The *Peastone* or *Pisolite* consists also of round or spheroidal masses, varying from the size of a pea to that of a hazel-nut, agglutinated like the last by a calcareous cement. Each of the globules generally contains a fragment of some foreign matter, as a grain of sand. At Klagenfurt in Carinthia, and at Carlsbad in Bohemia, it occurs in great quantities, the mineral waters in the vicinity of the latter rising from beds of pisolite.

*Chalk* is a massive opaque carbonate of lime of a white, greyish, or yellow colour, having an earthy fracture and low specific gravity. It varies much in hardness, but is generally soft to the touch, and adheres to the tongue; it composes also a large portion of the newest secondary rocks in the south of England, and contains abundance of marine as well as terrestrial organic remains. Its uses are well known, in furnishing lime for manure and cement, in polishing metals and glass, as a marking material, and in painting and whitewashing.

*Marl* is a mixture of limestone and clay, possessing an earthy fracture, a greater or less degree of compactness, and a yellowish or reddish-grey colour. Most of its varieties soften in water, and effervesce with acids. It occurs in considerable quantity in Thuringia, and is produced by the decomposition of shells in bogs and standing waters.

*Tufa*, or *Calcareous Tuff*, is the most impure, the most irregular, and the most porous of all the varieties of limestone, being an alluvial deposit from calcareous springs. It occurs in beds generally in the vicinity of

lakes and rivers, also encrusting rocks, and enveloping animal and vegetable remains. Probably no country in the world exhibits it under more varied aspects, and in larger masses, than Italy. Immense deposits have taken place at Terni, and on the banks of the river Anio, near Tivoli, where some very curious impressions, such as that of a cart-wheel, trunks of trees, and the like, are to be met with. The celebrated temples of Pæstum are formed of this stone, and no doubt owe their existence at the present period to the circumstance of its hardening on exposure; for as the quarries whence it has been procured are in the immediate vicinity, and the stone when raised is so much softer, modern Vandals have found it easier to go direct to the quarry for what they wanted, than attack the long weather-beaten and now indurated Doric pillars of the temples. From its property of hardening so much on exposure to the atmosphere and moisture, this rock makes a very useful building stone in the structure of bridges and docks. Over the Danube at Ulm a handsome bridge has lately been erected of this stone, which, when brought from the neighbouring mountains, is cut into the requisite dimensions with the axe and the saw.

*Agaric Mineral* or *Rock Milk* occurs on the surface and in the fissures of limestone rocks, and at the bottom of some lakes, in a loose or semi-indurated state. It is a pure carbonate of lime; is of a white colour, soft and meagre to the touch, soils the fingers, and is used in Switzerland for whitewashing the houses.

The crystallized sandstone of Fontainebleau in France (*chaux carbonatée quarzifère*) is a variety of calcareous spar mechanically mixed with sand, and, when crystallized, assuming the form of the acute rhomb. It is in fact the same in a crystalline state as the compact limestone of Berg, on the Danube between Linz and Vienna, which being charged with small quartz pebbles, affords a capital material for millstones.

Under the head of calcareous spar are also included the numerous varieties of *Marble* used in sculpture and ornamental architecture, and to which that distinguishing title is applied, in consequence of their possessing such degrees of hardness as to admit of a good polish. These are prized according to their purity, colour, delineations, translucency, size of the component individuals, and of the blocks which may be obtained free of fissures and blemishes; also according to the degree of polish they receive, &c. The islands of Naxos, Paros, and Tenedos, in the Archipelago, were celebrated in former times for the beauty of their statuary marbles, and many of the most splendid works of the ancient masters are executed in marbles from one or other of these localities. Their durability too is quite extraordinary, in some cases having been proof against the attacks of the elements during the lapse of perhaps 2000 years. "Of all natural substances used by the ancient artists," says Dr Clarke, "Parian marble, when without veins, and therefore free from extraneous bodies, seems to have best resisted the various attacks made upon Grecian sculpture: it is found unaltered, when granite, and even porphyry,



coeval as to their artificial state, have suffered decomposition." The red antique marble, rosso antico of the Italians, which was brought from Egypt; the verde antique, an intermediate mixture of white marble and green serpentine; the yellow antique; the Cipolin, marked with green-coloured zones produced by talc or chlorite; and the African breccia, are the principal coloured marbles of the ancients. The finest quarries of statuary marble now in Europe are, however, those of Carrara, on the east coast of the Gulf of Genoa. The hills in that neighbourhood consist of primitive white limestone, and are worked to the height of perhaps 800 feet; the rock not being compact, no regularity takes place in cutting it, but, as necessity may require, the labourer's tools are applied; large masses are loosened, undermined, and thrown down into the bed of the torrent, many hundred feet below; and then the portions approved of are cut into quadrangular masses, according as the blue veins which intersect them permit, and thereafter dragged upon carts four miles to the sea. By this means not one tenth of the marble which is loosened can be formed into blocks; but as it occurs in profusion, the quantity wasted is no object, and as the impure portions must at all events be rejected, the easiest, though not the most economical process, is certainly the one followed. Blocks of 600 or 800 cubic feet are procured in this manner at Carrara; and about 1000 hands are annually employed in quarrying it. The *Ruin, Landscape, or Cotham Marble* as it is called, from one of its localities near Bristol, exhibits when cut and polished the appearance of landscape or ruins; it is of common occurrence in the Val d'Arno, near Florence. The name *Lucullite*, as applied to black marble, arose from the quantity of that colour which Lucullus transported to Rome from an island in the Nile. One remarkable variety of shell marble, called *Lumachello*, forms beds in a portion of the lead mines of Bleiberg in Carinthia; exhibits beautiful iridescent colours; and, in consequence of its deep red or orange shades, has obtained the peculiar designation of *Fire Marble*.

The *Stinkstone, Swinestone, or Anthraconite*, which is found columnar, granular, and compact, and of various dark shades, emits a strong fetid odour when scraped, which is attributed to its including sulphuretted hydrogen. The compact black varieties, which receive a polish, are used in making chimney-pieces, and in other ornamental architecture. It commonly occurs alternating with compact limestone, and is found in Sweden, Carinthia, Kilkenny in Ireland, and in several parts of Great Britain. The compact limestone, which contains a slight admixture of silica and alumina, is an extremely useful flux in the smelting of such ores as are difficultly fusible. When brought into the state of quicklime, by depriving it of its carbonic acid, it is used for mortar; also, when free of magnesia, by the farmer in the improvement of particular kinds of soil; by the tanner for cleansing his hides, or freeing them from muscular fibre and hair; and in a variety of other useful operations.

A peculiar variety of very fine-grained compact limestone is used for

lithographic printing; the best quality for this purpose is procured near Pappenheim and Solenhofen in Bavaria. Some descriptions of limestone emit a phosphorescent light when struck in the dark, particularly the coarse-grained variety from Wermeland in Sweden; others contain a good deal of bitumen, and consequently present a brown or black colour, though, upon being calcined, they give out a bituminous odour, burn into quicklime, and become white. In Dalmatia it occurs so bituminous that it may be cut like soap, and is employed in the construction of houses, for which purpose, when finished, the walls are set fire to, the bitumen burns out, and the stone becomes whiter; the roof is afterwards put on, and the house completed.

Professor Mitscherlich has observed that the dihedral obtuse angle of calcareous spar diminishes by heat, or the short axis is more dilated than the others, so as to produce a variation in the measurement, of  $8^{\circ} 30'$ , in passing from the freezing to the boiling point, and thus to afford a form approaching that of the cube.

### DOLOMITE.

Macrotypous Lime Haloide, *M.* Dolomite, *J.* Bitter Spar, Rhomb Spar, Brown Spar, Pearl Spar, Miemite, Magnesian Limestone, *P.* Braunspath, Bitterkalk, Rautenspath, *W.* Braunkalk, *L.* Chaux Carbonatée Aluminifère; Chaux Carbonatée-magnésifère, -ferro-manganesifère, -ferrifère, *H.*

Sp. Gr. 2.88—2.95. H. = 3.5—4.0.

Rhombohedral. FIG. 1. Rhomb of  $106^{\circ} 15'$ , being so nearly that of calcareous spar that it was long considered the same. *Colour* white, seldom pure; also tinged red, green, and brown. *Translucent*, sometimes transparent. *Lustre* vitreous, in some varieties pearly. *Streak* greyish-white. *Cleavage* that of the rhomb, and *fracture* conchoidal. Carbonate of lime and carbonate of magnesia are its principal constituents, but their relative proportions vary considerably. Two analyses by Klaproth, and one by Thomson, afford the following results:

Carbonate of lime	68.0	51.5	54.25
Carbonate of magnesia	25.5	32.0	47.43
Alumina	2.0	0.0	0.68
Carbonate of iron	1.0	7.5	0.00
Carbonate of manganese	0.0	2.0	0.00
Water	2.0	5.0	0.00
Protoxide of iron	0.0	0.0	1.69

The varieties of this species are soluble in acids, but more slowly than calcareous spar, and they produce a much slighter



effervescence; before the blowpipe they are scarcely distinguishable from it. The chemical formula indicates 54.18 carbonate of lime, and 45.82 carbonate of magnesia.

## OBSERVATIONS.

This mineral, from the diversity of its component parts, and the different forms and appearances it assumes, has long puzzled both chemists and mineralogists. The massive white granular varieties, sometimes but slightly coherent, have been distinguished under the name of *Dolomite*; *Rhomb Spar* and *Bitter Spar* are the titles of crystallized or large grained and easily cleavable kinds; whilst *Brown Spar* and *Pearl Spar* comprehend those presenting a crystalline form, in which the lustre approaches to pearly, and the colours incline from white to red or brown. All these have been more or less united or distinguished by different mineralogists, until the natural-historical system of Mohs declared them to be merely varieties of the same species; and by attending closely to their specific gravities, they may easily be distinguished from any, either of the foregoing or succeeding. The finest crystallized and most transparent specimens of this mineral occur at Traversella in Piedmont, also at St Gothard, and near Gap in France. Pearl spar, which is much the most common variety, is met with in the lead mines of Alston in Cumberland, in Derbyshire, and at Leadhills; also in many places on the continent, as at Miemo in Tuscany, whence the name of *Miomite*, in Saltzburg, Hungary, Saxony, and the Hartz. Massive dolomite is found pure white in the primitive range of St Gothard, and, though closely resembling granular limestone, may be distinguished from that species by its feeble effervescence in acid. The ejected masses of limestone from Vesuvius (whether originally so, or changed by the action of heat) are exactly similar to dolomite. The *Gurhofian*, from Gurhof in Lower Austria is white, and, from its compactness, was at one time mistaken for a variety of semi-opal. An impure variety occurs in the form of globular earthy-like concretions, at Building Hill near Sunderland; the flexible schistose limestone from the same coast is another. The mortar obtained from this species is esteemed for cement, being, in consequence of its absorbing less carbonic acid from the atmosphere, less subject to decay than that of common limestone. For agricultural purposes, on the contrary, it is of inferior value, as, when laid on particular soils, it tends rather to injure than improve vegetation, which is wholly destroyed when the quantity is large; this effect is probably owing to the magnesia it contains. The Cathedral of Milan, and the Minster of York, are both built of magnesian limestone; the white marble of Paros, and that of Iona in the Hebrides, belong to this species; it therefore often admits, as well as limestone, of being cut and polished, and is described as being particularly durable.

## BREUNNERITE.

Brachytypous Lime Haloide, *M.* Brachytypous Limestone or Rhomb Spar, *J.* Carbonate of Magnesia and Iron, *P.*

Sp. Gr. 3·0—3·2. H. = 4·0—4·5.

Rhombohedral. Rhomb of  $107^{\circ} 22'$ . *Colour* yellowish or brown. Translucent. *Lustre* vitreous, sometimes inclining to pearly. *Cleavage* perfect parallel to the faces of the rhomb. *Fracture* conchoidal. Two varieties analysed by Stromeyer afforded

Magnesia	41·06	42·40
Protoxide of iron	8·57	6·47
Ox. of manganese	0·43	0·62
Carbonic acid	48·94	49·67

It dissolves without effervescence in nitric acid.

## OBSERVATIONS.

This mineral was distinguished by Mohs from the preceding species, varying as it does from it in specific gravity, crystallization, hardness, and appearance. It is named in honour of Count Breunner of Austria; and its best known localities are the Rothen-Kopf and Greiner mountains in the Zillerthal, Tyrol, where it occurs imbedded in chlorite slate and associated with crystals of dolomite, from which, however, it may at once be distinguished by its colour; the breunnerite being brown or yellow, whilst the other is white and translucent. Under similar circumstances it is met with imbedded in green foliated talc on the island of Unst, in Shetland.

## ANKERITE.

Paratomous Lime Haloide, *M.* Rohe Wand and Wandstein of the Styrian miners.

Sp. Gr. 2·95—3·1. H. = 3·5—4·0.

Rhombohedral. In crystalline masses, forming rhombs of  $106^{\circ} 12'$ . *Colour* white, though sometimes tinged yellow and brown, from an admixture of iron. Faintly translucent. *Lustre* vitreous. *Streak* white. *Cleavage* perfect parallel to the faces of the rhomb. *Fracture* uneven, and the surface generally striated. It contains carbonate of lime and carbonate of iron, though in what proportions has not been ascertained. It becomes black before the blowpipe, and acts upon the magnetic needle. In nitric acid it is soluble with a brisk effervescence; and on exposure to the air its surface becomes considerably darkened.



## OBSERVATIONS.

This species occurs at the Rathhausberg in the Gastein valley, Salzburg, and in considerable quantity at the Styrian mines of Eisenerz, where it is highly prized by the smelters, both as an iron ore, and as a flux in the process of smelting; it is also met with at Golrath and the Nieder Alp, in Styria. It was first distinguished by Mohs, who named it in compliment to Professor Anker, of the Johanneum in Gratz.

## CHILDRENITE.

$$H. = 4.5-5.0.$$

Prismatic. FIG. 48. Inclination of  $e$  to  $e = 130^{\circ} 20'$ ; of  $e$  to  $e$  over the edge  $x = 102^{\circ} 30'$ ; of  $e$  to  $e' = 97^{\circ} 50'$ ; of  $a$  to  $a = 124^{\circ} 54'$ . Colour yellow and yellowish-brown. Streak white. Translucent. Cleavage imperfect. Fracture uneven. A compound of phosphoric acid, alumina, and iron.—Wollaston.

## OBSERVATIONS.

It occurs in very minute crystals, disposed either singly or in crystalline coats, on carbonate of iron or quartz; its only known locality being the vicinity of Tavistock, in Devonshire. This mineral was discovered by Levy, who named it in honour of Mr Children.

## CARBONATE OF CERIUM.

*Berzelius.* Brewster's Journ. Vol. III. 334.

Occurs in thin four-sided crystalline plates of a greyish-white colour. According to Hisinger, it contains, oxide of cerium 75.7, carbonic acid 10.8, water 13.5. It does not change its appearance, though it loses 19 per cent. of its weight, when exposed to a slight red heat.

## OBSERVATIONS.

It forms coatings on the cerite from Bastnaes, in Sweden, and probably is derived from the decomposition of that mineral. It is extremely rare.

## MAGNESITE.

Carbonate of Magnesia, *Phil.*

$$\text{Sp. Gr. } 2.8. \quad H. = 3.0-4.0.$$

Occurs massive, amorphous, and reniform. Colour yellowish-white or grey. Opake. Dull. Streak white. Adheres pretty

strongly to the tongue. Composition impalpable. *Fracture* flat conchoidal ; sometimes earthy. Compound varieties very tough. It consists of

		Salem.
Magnesia	48·0	47·88
Carbonic acid	49·0	51·82
Water	3·0.—Klaproth.	0·00.—Stromeyer.

It is infusible before the blowpipe, but is dissolved with a slow effervescence in nitric or dilute sulphuric acid.

## OBSERVATIONS.

Some very slight indications of crystallization have been observed in specimens of this substance from Salem in the Carnatic, but not sufficient to render the form distinguishable. It occurs also at Hrubschitz in Moravia, at the Gulsen mountain in Styria, at Baumgarten in Silesia, at Baudissero in Piemont, in Spain, America, and other countries.

The variety from Baudissero contains 9·4 per cent. of silica, and has a considerably lower specific gravity ; in other respects it perfectly agrees, and is generally classed with the present species.

## ROSELITE.

Levy. Brewster's Journ. II. 1773

$$H. = 3\cdot0.$$

FIG. 49. Inclination of  $a$  to  $a$  over  $P = 47^{\circ} 12'$ . In small deep rose-red coloured twin crystals, having a vitreous lustre and white streak. Translucent. *Cleavage* distinct and brilliant parallel to  $P$ . According to Children, it contains wafer, oxide of cobalt, lime, arsenic acid, and magnesia ; and before the blowpipe gives off water and becomes black. It imparts a blue colour to borax and salt of phosphorus, and is entirely soluble in muriatic acid.

## OBSERVATIONS.

This is an extremely rare mineral, occurring, in so far as is known, only at Schneeberg in Saxony. It used to be considered a variety of cobalt-bloom, which it certainly resembles in colour, though very distinct in crystalline form. Levy noticed it in the collection of Mr Turner, in well-defined crystals on amorphous greyish quartz, and named it in honour of that talented mineralogist Dr Gustavus Rose of Berlin. The collections of the mining academy at Freyberg, and the university at Berlin, also contain specimens of this species.



## ORDER BARYTE.

### SPARRY IRON.

Brachytypous Parachrose Baryte, *M.* Sparry Iron, *J.* Spathose Iron, Carbonate of Iron, Brown Spar, *P.* Spatheisenstein, *W.* Eisenkalk, Sphærosiderit, *Haus.* Kohlen-saures Eisen, *L.* Chaux Carbonatée Ferrifere, Fer Oxidé-Carbonaté, *H.* Fer Carbonaté, *Levy.*

Sp. Gr. 3·6—3·9. H. = 3·5—4·5.

Rhombohedral. FIG. 1. A rhomb of  $107^{\circ}$  and  $73^{\circ}$ . *Colour* various shades of yellow, passing on exposure into grey, red, and brown. Transparent, translucent in different degrees, and opaque. *Lustre* vitreous or pearly. *Streak* white. *Cleavage* perfect parallel to the faces of the rhomb. *Fracture* slightly conchoidal. In two varieties Klaproth found

	Sphærosiderite.	Hartz.
Protoxide of iron	63·75	57·50
Carbonic acid	34·00	36·00
Oxide of manganese	0·75	3·30
Lime	0·00	1·25
Magnesia	0·52	0·00

the chemical formula of Berzelius expressing the ratio of 61·47 protoxide of iron to 38·53 carbonic acid. Before the blow-pipe it becomes black, and changes into a protoxide which acts upon the magnetic needle, but does not melt. It colours glass of borax green. It is difficultly soluble, and scarcely effervesces in nitric acid, unless previously reduced to powder.

#### OBSERVATIONS.

It is from this mineral that almost the whole of the Styrian and Carinthian iron is manufactured. In these and the bordering countries it forms coherent tracts which extend along the chain of the Alps on one side into Austria, and on the other into Salzburg. The celebrated Erzberg, between Eisenerz and Vordernberg in Styria, is composed of gneiss, upon which rests on the north and west sides an immense bed of sparry

iron. This is the great depot of ore which is used in the formation of the Styrian steel; and on this mountain alone nearly 1200 men are employed. Being of a crumbly nature, and much decomposed, it frequently breaks down, particularly in spring; and thus the proprietors who cart it from the foot of the mountain, and smelt it in the immediate vicinity, obtain an abundant supply of ore at a very trifling expense. The finest crystals of sparry iron come from Harzgerode in the Harz, where they occur in veins of considerable size, traversing grey-wacke. At Freiberg it is found in silver veins. In Cornwall several interesting crystalline varieties, particularly such as present the form of hexagonal prisms, have been met with accompanying tin; individual crystals exceeding two inches along their edges were found by Gièsecké associated with the cryolite in Greenland; and very beautiful forms at times occur in the mining districts of Alston Moor and Devonshire. In its massive state it decomposes speedily on exposure to the air; first the colour of the surface becomes brown or black, afterwards also the streak is changed into red or brown, and it soils the fingers, hardness and specific gravity are diminished, and even the chemical constitution is altered, its carbonic acid being driven off, and the whole converted into hydrate of iron. This gradual change may often be distinctly traced even in hand specimens. Another peculiarity is its frequent occurrence in the form of pseudomorphous crystals, as in those of calcareous spar from Cornwall.

The name of *Sphærosiderite* has been applied particularly to the spheroidal and radiated variety from Hanau, where it is met with occupying hollows in greenstone, without any indication of crystalline form. The sparry iron is also found fibrous, sometimes in beautiful brown silky laminae, as in Cornwall. Its property of being readily convertible into excellent steel renders this a highly valuable ore. It is distinguished from calcareous spar and dolomite, by its superior hardness and specific gravity.

### RED MANGANESE.

Macrotypous Parachrose Baryte, *M.* Carbonate of Manganese, *P.* Rother Braunstein, Braunspath, *W.* Kohlensaures Mangan, *L.* Manganese Oxyde Rose Silicifère Amorphe, Manganese Oxyde Carbonaté, Manganese Carbonaté, *H.* Rothbraunsteinerz, *Haid.*

Sp. Gr. 3.3—3.6. H. = 3.5.

Rhombohedral. FIG. 42. *Form* a rhomb of  $106^{\circ} 51'$ . *Colour* rose red of various shades. *Translucent.* *Lustre* vitreous, inclining to pearly. *Streak* white. *Cleavage* parallel to the faces of the rhomb. Surface of *o* deeply streaked parallel to the edges of combination with *P*. This produces lenticular crystals, and when the surface of *P* is curved, we have those peculiar saddle-shaped lenses so common in this species. It contains



Oxide of manganese	54.60
Carbonic acid	33.75
Oxide of iron	1.87
Silica	4.37
Lime	2.50.—Du Menil.

When pure it consists of 62.35 oxide of manganese, and 37.65 carbonic acid. Before the blowpipe its colour is changed into brown or black, and it decrepitates strongly, but is infusible without addition. It is easily soluble in and colours glass of borax violet blue, and effervesces rather briskly in nitric acid. On exposure to the air its natural colour is changed into brown, and many bright rose-red varieties become paler from the action of light.

## OBSERVATIONS.

This species generally occurs in metalliferous veins accompanying various ores of silver and lead, both massive, and in botryoidal concretions coating cavities. The mines of Freyberg in Saxony, and those of Kapnick, Offenbanya, and Nagyag, in Transylvania, are its principal localities.

It is apt to be confounded with manganese spar, though its greatly inferior degree of hardness is sufficiently characteristic.

## SILICATE OF ZINC.

Prismatic Zinc Baryte, *M.* Prismatic Calamine, or Electric Calamine, *J.* Silicious Oxide of Zinc, *P.* Galmei (in part), Zinkglas, *Haus.* Zinc Oxidé, Zinc Oxidé Silicifère, *H.*

Sp. Gr. 3.3—3.6. H. = 5.0 when crystallized, the massive varieties being somewhat less.

Prismatic. FIG. 26. Inclination of P to P =  $128^{\circ} 27'$ ; of M to M contiguous =  $103^{\circ} 53'$ . Occurs crystallized, stalactitic, mamillated, botryoidal, and massive. Most prevalent colour white, occasionally blue, green, yellow, or brown. Transparent, translucent, or opaque. Lustre vitreous. Streak white. Cleavage perfect parallel to M. Fracture uneven. Consists of

Altenberg.

Oxide of zinc	66.83	66.37
Silica	24.89	26.23
Water	7.46.—Berthier.	7.40.—Berzelius.

Reduced to powder it is soluble in heated sulphuric or muriatic acid, and the solution gelatinizes on cooling. Before the

blowpipe it decrepitates a little, loses its transparency, intumesces, and emits a green phosphorescent light. It is infusible without addition, but is dissolved by borax into a clear glassy globule, which becomes opaque on cooling. Some varieties are electric when rubbed or gently heated.

## OBSERVATIONS.

The present and following species were formerly considered the same; but the impossibility of uniting rhombohedral and prismatic forms pointed out the necessity of a separation, while the difference of specific gravity also afforded sufficient reason for this distinction. The two species, however, are frequently found accompanying each other in veins, associated with ores of blende, iron, and lead. Considerable quantities occur at Bleiberg and Raibel in Carinthia, often in extremely delicate crystals. Several beautiful varieties are met with near Freiburg in Brisgau, at Rezbanya in Hungary, Tarnowitz in Silesia, and Altenberg near Aix-la-Chapelle. Concentric botryoidal groups occur in the Mendip Hills, and at Wanlockhead in Dumfriesshire; and numerous pseudomorphous crystals of the same substance, assuming different forms of the carbonate of lime, are found in Derbyshire, and at Schemnitz in Hungary. Its properties of becoming electric when heated, and of forming a jelly with acids, serve to distinguish it from all other minerals it may resemble, except some of the zeolites; and from these its infusibility before the blowpipe is sufficiently characteristic.

## CARBONATE OF ZINC.

Rhombohedral Zinc Baryte, *M.* Rhombohedral Calamine, *J.* Calamine, *P.* Galmei (in part), *Wern.* Zinkspath, *L.* Zinc Carbonaté, *H.*

Sp. Gr. 4.2—4.5. H. = 5.0.

Rhombohedral. FIG. 1. *Form* rhomb of  $107^{\circ} 40'$ . *Colour*, like the last species, very various. Translucent, opaque. *Lustre* vitreous, inclining to pearly. *Streak* white. *Cleavage* perfect parallel to the faces of the rhomb; often curved. Smithson found two varieties from Derbyshire to contain

Oxide of zinc	65.20	64.64
Carbonic acid	34.80	35.36

the latter corresponding exactly with the chemical formula. It is soluble with effervescence in nitric and muriatic acids, but it does not, like the silicate of zinc, form a jelly with them. Before the blowpipe it is infusible, but loses its transparency, the carbonic acid is driven off, and the residue acts like pure oxide of zinc.



## OBSERVATIONS.

This species does not so often occur crystallized as the last, being more generally in botryoidal, stalactitic, or reniform masses, and having at times much the aspect of chalcedony. Some very fine varieties are found in Siberia; one of a dark brown colour containing cadmium, another of a beautiful bright green. Dognatzka, and the Bannat of Temeswar in Hungary, as well as most of the localities mentioned above, are common to this species. A compact fibrous semi-translucent variety of a pale yellow colour, disposed in concentric laminæ, occurs at Alston Moor in Cumberland. From both of these species Zinc is extracted.

## TUNGSTEN.

Pyramidal Scheelium Baryte, *M.* Pyramidal Tungsten, *J.* Tungstate of Lime, *P.*  
Schwerstein, *W.* Sheelit, *L.* Schéelin Calcaire, *H.*

Sp. Gr. 6.0—6.1. H. = 4.0—4.5.

Pyramidal. FIG. 50. The double four-sided pyramids in which this mineral generally occurs approach nearly to the regular octahedron. Two of its lateral angles are often replaced by the faces P, and lead to divers other modifications. *Colour* generally white, passing into yellow and brown. Semi-transparent. *Lustre* vitreous, inclining to adamantine. *Streak* white. *Cleavage* parallel both to the faces of the pyramid and to P. Consists of lime 19.40, oxide of scheelium 80.24, Berzelius, the chemical formula being nearly the same. Alone before the blowpipe it is infusible, except that the thinnest edges are converted at a high temperature into a semi-transparent vitrified mass. With borax it yields a white glass, whose transparency is proportioned to the quantity of salt employed. It assumes a yellow colour when thrown into nitric acid, but does not dissolve.

## OBSERVATIONS.

This mineral, when massive, has much the aspect of carbonate or sulphate of lead, and also barytes. It may, however, be distinguished from the two first by its not effervescing in acids; from the last by the yellow colour it assumes when placed in nitric acid; and from all three by its superior hardness. It occurs both crystallized and amorphous, particularly in the repositories of tin-ore at Schlaggenwald and Zinnwald, in Bohemia. The most beautiful crystals, however, are found associated with apatite, molybdena, and wolfram, in quartz, at Caldbeckfell near Keswick. It is likewise met with in Cornwall, in Sweden, at Schellgaden in Salzburg, at Harzgerode in Anhalt, and in America. Pseudomorphic crystals of wolfram, assuming the form of tungsten, also occur in Cornwall, at Wheal Maudlin.

## STRONTITES.

Peritomous Hal Baryte, *M.* Di-prismatic Baryte, or Strontianite, *J.* Carbonate of Strontian, *P.* Stronthian, *W.* Kohlensaurer Strontian, *L.* Strontiane Carbonatée, *H.*

Sp. Gr. 3.6—3.8. *H.* = 3.5.

Prismatic. FIG. 51. Regular crystals of this mineral are rare, as it generally occurs macled either in hexagonal prisms or six-sided pyramids, with re-entering angles. *Colour* asparagus green, yellowish-brown, and white. Transparent, translucent. *Lustre* vitreous. *Streak* white. *Cleavage* rather perfect parallel to *M*; less so to *P*. Contains

	Green.	Brown.
Carbonate of strontia	93.49	91.17
Carbonate of lime	6.28.—Thomson.	8.64.—Thomson.
With traces of manganese, iron, and alumina,		
Strontia	69.50	61.21
Carbonic acid	30.00	30.20
Water	0.50.—Klaproth.	8.59.—Hope.

Or, according to the formula of Berzelius, 70.16 of strontia, and 29.84 carbonic acid. It dissolves with effervescence in the muriatic and nitric acids; and paper dipped into this solution, and afterwards dried, burns with a red flame. Before the blowpipe it fuses only on the thinnest edges, the flame at same time assuming a reddish hue; but when very strongly heated, the carbonic acid and water are expelled, and the mass will not afterwards effervesce with acids. With borax, after violent effervescence, it forms a clear globule. The calcined spar, when water is poured on it, swells, bursts, and becomes hot in a greater degree, and with more rapidity, than lime. Its powder exhibits a phosphorescent light when heated in the dark. This mineral was described, and its properties first determined, by Dr Hope.

## OBSERVATIONS.

Its largest known crystals have been found at Leogang in Salzburg, of which fig. 51 is the drawing given by Mohs; but they are very rare. At Strontian, in Argyleshire, where it was first discovered, it occurs in veins which traverse gneiss, with galena and barytes, in massive, stellated, fibrous, and diverging groups, rarely exhibiting more than mere traces of crystallization. The finest asparagus green, as well as dark brown



fibrous varieties, are from this locality. In Yorkshire it is met with in acute snow-white pyramids, and at Braunsdorf in Saxony in brilliant white and brown hexagonal prisms. This last was long taken by Werner for aragonite, to which it bears considerable resemblance.

Strontites and all its combinations possess the remarkable property of tinging flame of a red colour. The muriate and nitrate have it in the most eminent degree; and, for that reason, in various proportions with other substances, these salts are in common use in pyrotechnic experiments. The beautiful red fire, for instance, so well known at the theatres, is prepared by a composition of 40 parts dry nitrate of strontia, 13 powdered sulphur, 5 chlorate of potash, and 4 sulphuret of antimony. As some of the varieties of strontites and barytes bear much similarity to one another, the best characteristic, in case of difficulty, is their comportment before the blowpipe. Every combination of the former colours the flame purplish red, while every combination of barytes produces a yellowish-green tint. The specific gravity of barytes is also considerably higher.

#### WITHERITE.

Di-prismatic Hal Baryte, *M.* Rhomboidal Baryte, *J.* Witherite, Carbonate of Barytes, *P.* Witherit, *Haus.* Kohlensaurer Baryt, *L.* Baryt Carbonateé, *H.*

Sp. Gr. 4.2—4.4. H. = 3.0—3.5.

Prismatic. General form resembling the common variety of quartz, but usually maced in a manner similar to the crystals of aragonite. *Colour* white, passing into yellow and grey. Semi-transparent, translucent. *Streak* white. *Lustre* vitreous, inclining to resinous. *Cleavage* imperfect, and *fracture* uneven. Contains, baryta 79.66, carbonic acid 20.00, water 0.33, Bucholz. The chemical formula corresponds to 77.66 baryta, and 22.34 carbonic acid. Before the blowpipe it decrepitates, and melts easily into a transparent globule, which becomes opaque on cooling. It is soluble with effervescence in dilute nitric or muriatic acids.

#### OBSERVATIONS.

This mineral is named after Dr Withering, its discoverer. It is found abundantly in the lead mines of Cumberland, generally in globular, reniform, and botryoidal shapes, but of late also in well-sized transparent crystals. At Anglezark in Lancashire, the compact fibrous and translucent variety occurs, which is so highly deleterious that it is used in the northern parts of England for the purpose of poisoning rats. Styria, Hungary, Siberia, and Sicily are also mentioned as localities of Witherite, but it is only in England that it is met with in any abundance.

The solubility of this substance in acids serves to distinguish it from barytes; and its comportment before the blowpipe at once separates it from strontites and celestine.

## BARYTES.

Prismatic Hal Baryte, *M.* Prismatic Baryte or Heavy Spar, *J.* Sulphate of Barytes, *P.* Schwerspath, *W.* Hepatit, *Haus.* Schwefelsaurer Baryte, *L.* Baryte Sulfatée, *H.*

Sp. Gr. 4.4—4.7. H. = 3.0—3.5.

Prismatic. FIG. 52. Inclination of *o* to *o* over the lateral edge =  $105^{\circ} 6'$ , of *M* to *M* over *s* =  $101^{\circ} 42'$ , of *d* to *d* over *P* =  $102^{\circ} 33'$ . Cleavage perfect parallel to the faces *P* and *M*. Most prevalent colour white; sometimes yellow, red, blue of various tints, and brown. Transparent or translucent. Lustre vitreous, inclining to resinous. Streak white. Consists of baryta 66.00, sulphuric acid 34.00, Berthier; the chemical formula corresponding to 65.63 of baryta, and 34.37 of sulphuric acid. Many of the varieties however contain impurities, such as silica, alumina, oxide of iron, &c. Before the blowpipe it decrepitates, and is difficultly fusible; and in some cases loses its colour on exposure to heat. It may be distinguished from celestine by the difficulty of fusion.

## OBSERVATIONS.

Two very distinct series of crystals may be traced among the forms of this mineral, according as the faces *P*, or *o* and *d*, are enlarged. In the first case, we have those fine tabular-shaped individuals so common at Dufton and in Hungary; in the second, such prismatic forms as are met with in Auvergne. In my father's collection there is a very regular single crystal of the former description from Dufton, which measures ten inches across the face *P*, and weighs forty-two pounds. Indeed, for the size and beauty of its specimens, Dufton much surpasses any other locality. Many elegant forms, though on a smaller scale, occur at Przibram and Mies in Bohemia. Individuals of large dimensions, and exhibiting splendid colours, are met with at Felsobanya and Cremnitz in Hungary; while crystals also of considerable size, and in which the plane *P* is sometimes totally wanting, are found at Roya and Raure in Auvergne. Besides the more distinctly crystallized varieties, the following have been described by mineralogists as subspecies of barytes, though in fact differing only in appearance.

*Granular Heavy Spar*, a name given to such massive varieties as consist of impalpable particles of composition. *Columnar Heavy Spar*, the *Stangenspath* of Werner, which occurs generally in indistinct prismatic crys-



tals, having a white shining pearly lustre; it is almost peculiar to Freyberg in Saxony. *Radiated Heavy Spar*, or *Bolognese Stone*, forming rounded masses which consist of columnar particles diverging more or less from a common centre; it is best known from Monte Paterno, near Bologna, where it accompanies gypsum in clay. This last, and several other varieties of barytes, emit a phosphorescent light when carefully heated, and retain that property for some time even after cooling. The Bolognese phosphorus, as it is called, is formed by mixing the powder of this mineral with a little gum, and exposing it to a slight red heat, when, after being placed some time under the influence of the solar rays, it possesses the property of phosphorescing in the dark. The *Cawk* of Staffordshire and Derbyshire is an opaque, massive, earthy-looking variety, of a dirty-white colour; while the name *Hepatite* has been applied to such specimens as on being rubbed or heated, emit a fetid, sulphureous, or hepatic odour, and are generally of a yellow or brown colour. Barytes is one of the most common accompaniments of metallic minerals in veins, and, when associated with ores of iron, possesses a deleterious influence upon the process of smelting. The pure white varieties are ground, and used as a white paint, either alone or mixed with white lead; but it is otherwise of no great value. Barytes, and all its salts, except one, are violent and certain poisons, destroying animal life by inflaming the intestines. The nitrate is used in pyrotechny, in the composition for making a green flame. For this purpose the ingredients are mixed in the following proportion: Flowers of sulphur 13, chlorate of potash 5, nitrate of barytes 77, metallic arsenic 2, charcoal 3. These, when well dried and burnt in a reflector, afford a brilliant green light.

## CELESTINE.\*

Prismatoidal Hal Baryte, *M.* Axifrangible Baryte or Celestine, *J.* Sulphate of Strontian, *P.* Zolestin, *Wern.* Schwefelsaurer Strontian, *L.* Strontiane Sulfatée, *H. Soret*, *Mém. de la Société de Physique de Geneve*, Tom. I.

Sp. Gr. 3·6—4·0. H. = 3·0—3·5.

Prismatic. FIG. 53. Inclination of *o* to *o* =  $103^{\circ} 58'$ , of *M* to *M* =  $103^{\circ} 38'$ , of *d* to *d* =  $101^{\circ} 25'$ . Colour commonly white, passing into blue and sometimes red tints. Transparent, translucent, or opaque. Streak white. Lustre vitreous, inclining to resinous. Cleavage perfect parallel to *P*, less so to *M*. Very brittle. Contains strontia 58·00, sulphuric acid 42·00, Klaproth; being, according to the chemical formula, in the proportions of 56·36 to 43·64. Before the blowpipe it decrepitates,

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\* So named from its occasional delicate blue colour.

and melts into a white friable enamel. It loses its transparency on being heated, and, when reduced to powder, phosphoresces on red hot iron.

## OBSERVATIONS.

The celestine and barytes have so much similarity, that it is only the higher degree of specific gravity possessed by the latter, and the slight difference in their angles, that serve to distinguish them. The sulphur mines of Sicily have long been celebrated for their magnificent groups of this substance. It there occurs in prismatic crystals, often beautifully transparent, aggregated, and either disposed on or accompanied by sulphur and gypsum. Very large tabular crystals, several inches in diameter, and of a bluish tinge, have been found at Strontian Island, in Lake Erie; while numerous interesting forms on a smaller scale occur at Bex in Switzerland, at Conil in Spain, near Bristol, and in the Vicentine. It is met with in straight fibrous concretions of a blue colour, imbedded in clay at Dornberg near Jena, and at Frankstein in Pennsylvania; in radiated scoopiform groups, opaque, and of a bluish tinge, in red clay, at Aust Ferry near Bristol, and in trap rocks near Tamtallan in East Lothian; crystalline and massive in magnesian limestone near Knaresborough in Yorkshire; radiating and fibrous at Norton in Hanover (a variety which, according to Dr Turner, *Phil. Jour.* xi., contains about 20 per cent. of sulphate of barytes); and in earthy nodules, cracked, and hollow, at Mont-Martre near Paris. At Monte Viale, in the Vicentine, it is frequently found in vesicular cavities of amygdaloidal rocks, accompanying analcime and other minerals of the zeolite family.

## BARYTO-CALCITE.

Hemiprismatic Hal Baryte, *M.* Baryto-Calcite, *Brooke.*

Sp. Gr. 3.6—3.7. H. = 4.0.

Hemi-prismatic. FIG. 54. Inclination of *M* to *M* over the face *h* =  $106^{\circ} 54'$ , of *b* to *b* =  $95^{\circ} 15'$ , of *h* to the edge between *b* and *b* =  $119^{\circ}$ , of *P* to the same edge =  $135^{\circ}$ . Colour white, yellow, or greyish. Transparent, translucent. Streak white. Lustre vitreous, inclining to resinous. Cleavage perfect, and easily obtained parallel to the faces *M* and *P*. Children found it to consist of carbonate of barytes 65.9, carbonate of lime 33.6. It does not fuse on exposure to the blowpipe, but, with borax in the oxydating flame, affords a diaphanous globule of a light amethystine tinge, which becomes colourless in the reducing flame. It effervesces considerably with acids.



## OBSERVATIONS.

This mineral was first described by Brooke. It occurs both crystallized and massive in considerable quantities at the lead mines of Alston in Cumberland, and appears to be peculiar to that locality. Some of its crystals are of considerable dimensions, being upwards of an inch and a half in length; but these large ones generally exhibit that peculiar mode of decomposition mentioned in the introductory remarks on the parasitic formation of minerals, by which they are gradually converted into a white mealy-like mass, apparently heavy spar.

## CARBONATE OF LEAD.

Diprismatic Lead Baryte, *M.* Diprismatic Lead Spar, *J.* Carbonate of Lead, *P.* Weissbleierz, Schwartz Bleierz, Blei Erde, *Wern.* and *Hoff.* Bleiweiss, Blei-schwartz, *Haus.* Kohlensaures Blei, *L.* Plomb Carbonatée, *H.*

Sp. Gr. 6.3—6.6. H. = 3.0—3.5.

Prismatic. FIG. 55. Inclination of *M* to *M* =  $117^{\circ} 13'$ , of *t* to *t* =  $130^{\circ}$ , of the same over the face *M* =  $108^{\circ} 28'$ , of *u* to *u* =  $110^{\circ} 40'$ . Either colourless or white, passing into grey and greyish black; tinged also green and blue by admixture with ores of copper. Transparent, translucent. *Streak* white. *Lustre* adamantine, passing into resinous. *Clearance* parallel to *M* and *u*, often interrupted by conchoidal fracture. Very brittle. Is composed of

	Leadhills.	Nertschinsk.
Oxide of lead	82.0	84.3
Carbonic acid	16.0	15.5
Water	2.0—Klaproth.	0.0—John.

which corresponds to the chemical formula for 83.52 oxide of lead, and 16.48 carbonic acid. The black varieties are said to derive their colour from a small portion of carbon which they contain. It is easily soluble, and with effervescence, in dilute nitric acid. Before the blowpipe it decrepitates, becomes yellow, then red, and, if properly managed, yields at last a globule of metallic lead.

## OBSERVATIONS.

The accompanying figure presents one of the most simple forms of this species; but there are few substances whose crystallizations are more complex. The individuals, too, being usually maced, in general small, and the number of their facets often very numerous, accounts for some of the more complicated forms having hitherto been less perfectly known.

Leadhills and Wanlockhead have long been celebrated as the Scotch localities of this mineral. It there occurs with other ores of lead, particularly the phosphate, sulphate, sulphato-tri-carbonate, and cupreous-sulphate, accompanying galena in transition slate. Very beautiful crystals are found in the mining districts of Saxony particularly at Johanngeorgenstadt, at Nertchinsk and Beresof in Siberia, near Bonn on the Rhine, at Clausthal in the Hartz, at Tarnowitz in Silesia, at Bleiberg in Carinthia, and at Mies and Przibram in Bohemia. It has also been met with in England at Alston Moor, Keswick, and particularly in Cornwall, where, at the mine of St Minvers, it occurs in snow-white and easily frangible crystals, so delicate as almost to preclude the possibility of transport. The stalactitic and stellated varieties principally occur at Leadhills and Wanlockhead, the compact and massive at Alston; and in some of the old lead mines at Dufton and elsewhere, it forms deposits and incrustations. A great proportion of the carbonate of lead appears to be of very recent formation, produced by the decomposition of galena, and deposited from water in which it has been in solution. Hence the stalactitic forms above mentioned, and the incrustations so often found on pieces of wood left in the mines, or on stones and other rubbish. Opake pseudomorphous crystals, taking the form of the sulphate of lead, have been met with at Leadhills; and of the earthy-lead-spar, as it is called, Poland and Silesia are the best known localities. When transparent, the carbonate of lead is doubly refractive in a high degree.

If in considerable quantity, it is valuable as an ore of lead; and undergoes along with galena the usual process of smelting. The circumstance of the carbonate occurring so frequently in twin crystals serves as one of its most distinguishing features; the sulphate of lead, which, in respect to colour, lustre, &c. bears much similarity, having never as yet been met with maced.

### PHOSPHATE OF LEAD.

(Under which head is also included the Arseniate of Lead.)

Rhombohedral Lead Baryte, *M.* Rhomboidal Lead Spar, *J.* Phosphate of Lead, Arseniate of Lead, *P.* Braunbleierz, Grunbleierz, *Wern.* and *Hoff.* Pyromorphit, Traublenblei, *Haus.* Phosphorsaures Blei, *L.* Plómb Phosphaté, *H.*

Sp. Gr. 6.9—7.3. H. = 3.5—4.0.

Rhombohedral. FIG. 44. Inclination of  $x$  to  $x = 142^{\circ} 12'$ . Colour green, yellow, or brown, of every possible hue. Transparent, translucent, and opake. Streak white, sometimes yellowish. Lustre resinous. Cleavage indistinct parallel to  $s$  and  $n$ . Fracture conchoidal, but not shining. In two varieties,—one of a brown colour from Huelgoet in Brittany, the other a





colour at Glenmalaur in the county Wicklow;\* at Zschopau in Saxony; Przibram, Bleistadt, and Mies in Bohemia; at Poullaouen and Huelgoet in Brittany; in the Hartz, and elsewhere on the continent. The varieties from Leadhills are more remarkable for the richness of their colours than the beauty of their crystalline forms, being generally aggregated, grouped in rosettes, forming superficial coatings, and otherwise indistinctly defined. The Reverend W. Vernon has ascertained orange phosphate of lead from Leadhills to contain about one per cent. of the chromate, to which admixture he attributes the splendid tinges of that variety. This accounts for its colour remaining unaltered when heated in the exterior flame of the blowpipe, while in the interior flame it assumes a green hue from the reduction of the chromic acid. The mamillated arseniate of lead occurs at Huelgoet, while the reniform and orbicular varieties are met with at the Puy de Dome in Auvergne, and in the Grand Duchy of Baden.

### CHROMATE OF LEAD.

Hemi-prismatic Lead Baryte, *M.* Prismatic Lead Spar, or Red Lead Spar, *J.* Chromate of Lead, *P.* Rothbleierz, *Wern.* and *Hoff.* Kallochrom, *Haus.* Chromsaures Blei, *L.* Plomb Chromaté, *H.* *Soret*, Annales des Mines, 1818.

Sp. Gr. 6.0—6.1.  $H = 2.5$ .

Hemi-prismatic. FIG. 56. Inclination of  $t$  to  $t = 119^\circ$ , of  $M$  to  $M = 93^\circ 40'$ . Colour hyacinth red. Translucent, sometimes only on the edges. Streak orange yellow. Lustre adamantine. Cleavage pretty distinct parallel to  $M$ ; very brittle, with an uneven cross fracture. It consists of

Oxide of lead	68.0	63.96
Chromic acid	32.0—Pfaff.	36.40—Thenard.

corresponding to the chemical formula expressive of 68.15 oxide of lead, and 31.85 chromic acid. Before the blowpipe it becomes black, and decrepitates if quickly heated; it may be melted, however, into a shining slag, containing globules of metallic lead. It is partly reduced in glass of borax, and colours it green; it is soluble without effervescence in nitric acid, and produces a yellow solution.

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\* One specimen from this locality in my father's collection, affords an admirable instance of the identity, in a mineralogical point of view, of the phosphate and arseniate of lead. It consists of large six-sided prisms of the phosphate, having a dark clove-brown colour, the sides and each extremity of which are covered with the arseniate crystallized in parallel position to its nucleus, and forming along with it the same regular six-sided prism.



## OBSERVATIONS.

Of this rare and beautiful mineral there exist only a few known localities, the principal of which is Siberia. It occurs near Beresof, in narrow veins, traversing decomposed gneiss, and associated with gold, iron pyrites, galena, quartz, and Vauquelinite. In Brazil, at Conconhas do Campo, its crystals are equally fine both in form and in colour; it there occurs in granite much decomposed, and is found very sparingly. Tarnowitz in Silesia is another locality ascribed to this mineral.

The chromate of lead is perhaps the most beautiful of all the combinations of that metal; specimens of it have always borne a very high price, and it is only during the last year or two that they have come within the means of most collectors. It is said to be used as a fine orange-coloured pigment in the porcelain manufactories of St Petersburg; but on exposure in a powdered state it changes to a dirty ochre yellow in the course of a very few hours, and when mixed with oil the light acts on it with even greater rapidity.

## MOLYBDATE OF LEAD.

Pyramidal Lead Baryte, *M.* Pyramidal Lead Spar, *J.* Molybdate of Lead, *P.* Gelbleierz, *Wern.* Bleigelb, *Haus.* Molybdansaures Blei, *L.* Plomb Molybdaté, *H.*

Sp. Gr. 6.5—6.9. H. = 3.0.

Pyramidal. FIG. 57. Inclination of P to P = 99° 40', of P to P' = 131° 35'. Colour wax yellow, passing into orange yellow; sometimes greenish. Translucent or opaque. Lustre resinous. Streak white. Cleavage parallel to P. Fracture conchoidal. Brittle. Contains,

Oxide of lead	64.42	58.40
Molybdic acid	34.25	38.00
Oxide of iron	0.0—Klaproth.	2.08—Hatchett.

the chemical formula for which is equivalent to 60.86 oxide of lead, and 39.14 molybdic acid. It is slowly and with difficulty soluble in acids. Before the blowpipe it decrepitates briskly, and assumes a darker colour; and on charcoal it fuses into a dark-grey mass, in which globules of reduced lead are visible.

## OBSERVATIONS.

Though the pyramid here given is that peculiar to the molybdate of lead, it much more frequently occurs in flat tabular crystals, produced by the deep truncations of the acute four-sided pyramid. At Schwarzenbach, Bleiberg, and Windisch-Kappel in Carinthia, it occurs in beds and veins of limestone, along with other ores of lead. It is also met with at Rezbanya in Hungary, and at Moldawa in the Bannat, where its crys-

tals have at first sight much resemblance, particularly in colour, to the chromate. The collection at the Johanneum in Gratz is extremely rich in this species, one which, until within these few years, was comparatively rare in the west of Europe.

### SULPHATE OF LEAD.

Prismatic Lead Baryte, *M.* Tri-prismatic Lead Spar, *J.* Sulphate of Lead, *P.* Vitriolbleierz, *Wern.* Bleivitriol, *Haus.* and *L.* Plomb Sulfaté, *H.*

Sp. Gr. 6.2—6.3. H. = 3.0

**Prismatic.** FIG. 58. Inclination of M to M over the terminal edge =  $103^{\circ} 49'$ , of *d* to *d* over P =  $101^{\circ} 15'$ . Colour white, tinged yellow, grey, green, and even blue. Transparent, translucent, and opaque. Streak white. Lustre highly adamantine in some specimens, inclining to vitreous in others. Cleavage parallel to P and M, but imperfect and interrupted. Structure lamellar. Fracture conchoidal. Very brittle. Contains,

Oxide of lead	72.47	70.5
Sulphuric acid	26.09	25.75
Water	0.12	2.25
Silica	0.51—Stromeyer.	0.00—Klaproth.

and a little oxide of iron and manganese; its composition when pure, being, according to the chemical formula, 73.56 oxide of lead, and 26.44 sulphuric acid. It decrepitates in the flame of a candle, and frequently assumes a reddish tinge on the surface. Reduced to powder, it melts easily before the blowpipe into a white slag, which is reduced on the addition of soda.

### OBSERVATIONS.

The largest and most beautiful crystals of this mineral are found at the mines of Wanlockhead and Leadhills, often in transparent tabular-shaped individuals some inches in diameter. Pary's Mine in Anglesea, and Mellanoweth in Cornwall, are its principal English localities; while on the Continent it is met with at Clausthal and Zellerfeld in the Hartz, Badenweiler in the Brisgau, and elsewhere. Small but extremely perfect transparent crystals have been brought from Fondon in Granada, while the massive and compact varieties are principally from Siberia, Andalusia, and Alston Moor.

Many of the ores of lead are unquestionably derived from the decomposition of galena, and none more distinctly so than the sulphate, which not only contains the same ingredients, but is frequently met with at Leadhills, either occupying the cavities of cubical crystals, or disposed on a surface of galena, which has all the appearance of having been acted upon by acids.



## SULPHATO-TRI-CARBONATE OF LEAD.

Axotomous Lead Baryte, *M.* Plomb Carbonaté Rhomboidal, *Bournon*.

Sp. Gr. 6.2—6.4. H. = 2.5.

Hemiprismatic. FIG. 59. Inclination of  $a$  to  $b = 90^\circ 29'$ , of  $c$  to  $c = 120^\circ 20'$ , of  $b$  to  $c = 119^\circ 50'$ . Colour white, passing into pale yellow, green, or grey. Translucent. Streak white. Lustre resinous, inclining to adamantine; pearly on the face  $a$ . Cleavage perfect, and easily obtained parallel to  $a$ . Sectile. Contains Carbonate of lead 71.1 7.25

Sulphate of lead 30.0—Berzelius. 27.5—Brooke. with traces of lime and muriatic acid. Before the blowpipe it intumesces and becomes yellow, but re-assumes its white colour on cooling. It effervesces briskly in nitric acid, leaving a white residue.

## OBSERVATIONS.

The sulphato-tri-carbonate of lead was first described and named by Brooke, and by him assigned to the rhombohedral system, until the investigations of Haidinger (*Royal Society Trans.* x. 217), and the double system of coloured rings observed in it by Sir David Brewster, decided it as appertaining to the prismatic forms. It has hitherto been principally found at Leadhills, accompanying other ores of lead in a vein traversing grey-wacke, though it is also mentioned as occurring in the province of Grenada in Spain. The crystals seldom exceed an inch in diameter, generally they are much smaller; and when macled, as is not unfrequently the case, present forms which are very difficultly determinable. The pearly lustre of the face  $a$  is one of its most distinctive characteristics.

## SULPHATO-CARBONATE OF LEAD.

Prismatoidal Lead Baryte, *Haid.* Schwefel-und-Kohlensaures Blei of the Germans.

Sp. Gr. 6.8—7.0. H. = 2.5.

Hemi-prismatic. FIG. 60. Oblique angular four-sided prisms, the faces  $b$  rounded, the crystals aggregated lengthways, and seldom distinct. Colour greenish white, pale yellow, or grey. Transparent or translucent. Lustre adamantine, inclining to resinous; pearly upon the perfect face of cleavage. Streak white. Cleavage perfect, and easily obtained parallel to a plane which replaces the acute lateral edges. The laminae obtained

by cleavage are flexible, like gypsum. Consists of carbonate of lead 46·9, sulphate of lead 53·1—Brooke. It dissolves in nitric acid without perceptibly effervescing, and before the blowpipe fuses into a globule, which is white when cold.

## OBSERVATIONS.

It occurs at Leadhills along with other ores of lead, and, like the preceding species, was distinguished by Mr Brooke. A massive variety has within these few years been noticed in Siberia.

## CUPREOUS SULPHATO-CARBONATE OF LEAD.

Paratomous Lead Baryte, *Haid.* Schwefel-und-Kohlensaures Blei-und-Kupfer of the Germans.

Sp. Gr. 6·4. H. = 2·5—3·0.

Prismatic. FIG. 61. Inclination of M to M = 95°. Colour bright verdigris green, or bluish. Translucent. Streak greenish-white. Lustre resinous. Cleavage indistinct, parallel to M, *h*, and P. Rather brittle. Consists of sulphate of lead 55·8, carbonate of lead 32·8, carbonate of copper 11·4—Brooke.

## OBSERVATIONS.

Sometimes the crystals of this very beautiful mineral are large and well defined, at others it appears in small tufts radiating from their common point of attachment. It occurs only at Leadhills, accompanying the preceding and other varieties of the lead ores from that locality.

## CUPREOUS SULPHATE OF LEAD.

Diplogenic Lead Baryte, *Haid.* Schwefelsaures Blei-und-Kupfer of the Germans.

Sp. Gr. 5·3—5·5. H. = 2·5—3·0.

FIG. 62. (Given by Haidinger.) Inclination of M to T = 95° 45', of *b* to *b* = 119'. Colour deep azure blue. Translucent. Streak pale blue. Lustre vitreous, or adamantine. Cleavage very perfect parallel to M, less so to *c*. It consists of sulphate of lead 74·4, oxide of copper 18·0, water 4·7—Brooke.

Before the blowpipe it affords indications of copper and lead.

## OBSERVATIONS.

This is a rare mineral even at Leadhills, which is its only well ascertained locality, although it is mentioned also from Linares in Spain. It was first noticed by Sowerby, and described in his *British Mineralogy*



as carbonate of copper, being, in colour at least, similar to the variety from Chessy. The crystals are macled, and generally disposed in cavities along with some of the foregoing species.

### MURIATE OF LEAD.

Peritomous Lead Baryte, *M. Berzelite, Levy.* Salzsaures Blei von Mendip of the Germans.

Sp. Gr. 7·0—7·1. H. = 2·5—3·0.

In masses having a fibrous columnar structure. *Colour* white, with a yellow or reddish tinge. Feebly translucent and opake. *Lustre* pearly upon faces of cleavage. *Cleavage* highly perfect and easily obtained parallel to a four-sided prism of  $102^{\circ} 27'$ . Consists, according to Berzelius, of oxide of lead 90·13, muriatic acid 6·84, carbonic acid 1·03, water 0·54, silica 1·46. Its carbonic acid being supposed accidental, Berzelius considers the present species a compound of two atoms of oxide and one atom of chloride of lead, in the proportion of 38·28 to 61·72. It decrepitates slightly before the blowpipe, and is easily fused, the globule presenting a deeper yellow than the mineral. On charcoal it is reduced, and emits fumes of muriatic acid. Treated with peroxide of copper and salt of phosphorus, the flame assumes an intense blue colour.

#### OBSERVATIONS.

The Mendip Hills in Somersetshire are the principal locality of this rare mineral. It is there found in crystalline masses, having a fibrous and radiated structure, disposed on earthy black manganese. It is said to occur as a product of sublimation upon the lava of Vesuvius; but from that locality the specimens are so indistinct as to render its identity doubtful. Caldbeck near Keswick is also mentioned.

### MURIO-CARBONATE OF LEAD.

Brachytypous Lead Baryte, *M. Corneous Lead, J. Hornblei of the Germans.* Plomb-Murio-Carbonaté, *Levy.*

Sp. Gr. 6·0—6·1. H. = 3·0.

FIG. 63. Inclination of *c* to *g* =  $135^{\circ}$ . *Colour* white, grey, and yellow. Transparent, translucent. *Streak* white. *Lustre* adamantine. *Cleavage* parallel to *g*. Rather sectile. Consists of oxide of lead 85·5, muriatic acid 8·5, carbonic acid 6·0—Klaproth. Before the blowpipe it fuses quickly into a yellow

globule, which becomes white and crystallizes upon the surface on cooling. At a high temperature the acid flies off, and minute globules of lead remain.

## OBSERVATIONS.

Very few specimens of this mineral are known. Its localities are Matlock in Derbyshire, Hausbaden near Badenweiler in Germany, and Southampton in Massachusetts U. S. where it accompanies other ores of lead, fluor spar, barytes, &c.

## TUNGSTATE OF LEAD.

Scheelsaures Blei. Plomb Tungstaté, *Levy*.

$$H. = 3.0.$$

In aggregated indistinctly formed four-sided prisms. *Colour* yellowish grey. Faintly translucent. *Lustre* resinous. *Cleavage* parallel to the base of a four-sided prism. *Fracture* conchoidal and shining. Contains, according to *Levy*, oxide of lead 48.0, and tungstic acid 52.0. Before the blowpipe it melts and gives off vapours of lead, leaving a dark-coloured metallic-like crystalline globule, which affords a pale-grey powder. When the lead has been driven off, it yields with borax a yellow bead, which is transparent and deep red on cooling; and with salt of phosphorus, at a certain degree of saturation, a blue one in the reducing flame.

## OBSERVATIONS.

The tungstate of lead occurs at Zinnwald in Bohemia associated with quartz and mica, and was first noticed as a particular species, and subjected to chemical examination, by Messrs Breithaupt and Lampadius. *Levy* mentions it from Bleiberg in Carinthia accompanying the molybdate of lead.

## PLOMBGOMME.

Hydrous Aluminate of Lead, *P.* Bleigummi of the Germans. Plomb Hydro-Alumineux, *H.*

$$H. = 4.0-5.0.$$

Reniform, or in globular masses, resembling in colour and appearance the substance called gum-arabic. Yellowish and reddish brown. Translucent. *Fracture* conchoidal. According to *Berzelius*, it consists of oxide of lead 40.14, alumina 37.00, water 18.80, with minute portions of sulphurous acid, lime, si-



lica, and the oxides of iron and manganese. When quickly heated before the blowpipe, it decrepitates and loses its water, but is infusible by itself. Neither is the reduction of the lead accomplished when fused with borax, though it yields a transparent colourless glass. It acquires negative electricity when rubbed.

## OBSERVATIONS.

It occurs at Huelgoet near Poullaouen in Brittany, associated in clay slate with galena, blende, and iron pyrites. There are certain varieties of mamillated blende, to which it bears much resemblance.

## WHITE ANTIMONY.

Prismatic Antimony Baryte, *M.* Prismatic White Antimony, *J.* Oxide of Antimony, *P.* Weiss-Spies Glaserz, *W.* and *Hof.* Spiessglanzweiss, *Haus.* Antimonbluthe, *L.* Antimoine Oxi  , *H.*

Sp. Gr. 5.5—5.6. H. = 2.5—3.0.

Prismatic. Crystallized generally in rectangular plates having two lateral faces inclined to each other at an angle of  $136^{\circ} 58'$ , or in acicular rhombic prisms. *Colour* snow-white, sometimes peach-blossom red and ash-grey. *Translucent.* *Streak* white. *Lustre* adamantine, shining, and pearly. *Cleavage* in two directions parallel to the lateral faces of the plate, highly perfect, and easily obtained. Contains oxide of antimony 86.0, oxide of antimony and iron 3.0, silica 8.0—Vauquelin. It is, according to Berzelius, pure oxide of antimony, equal to 84.32 of metal, and 15.68 of oxygen. It melts at the flame of a candle, and before the blowpipe is entirely volatilized, producing a white coating upon the charcoal.

## OBSERVATIONS.

This substance is frequently produced during chemical operations, and crystallized from sublimation. When metallic antimony is fused before the blowpipe, it emits fumes which crystallize round the globule, and at last entirely cover it. First, yellowish octahedral crystals, probably of antimonious acid, are formed, and then a beautiful tissue of acicular prisms of oxide of antimony, which admit of measurement by the reflective goniometer. It occurs in small quantities in veins traversing primitive rocks at Prizibram in Bohemia, where, in particular, the aggregated tabular crystals are found; while the prismatic variety is met with at Bra  nsdorf near Freyberg in Saxony, at Malaczka in Hungary, and elsewhere on the continent.

## FLUATE OF CERIUM.

*Fluss-Saures Cerium of the Germans.*

Of this mineral Berzelius has described three different species, which, for the sake of perspicuity, shall be mentioned separately.

1. The Neutral or Deuto-Fluate of Cerium, which occurs in six-sided prisms, in plates, and in amorphous masses of a reddish colour. Berzelius found it to consist of fluate of protoxide of cerium 30·43, fluate of peroxide of cerium 68·00, with some traces of yttria. Heated in a tube it corrodes the glass, but before the blowpipe on charcoal does not fuse, but merely changes its colour to brown; with borax and salt of phosphorus it gives a red or orange-coloured globule, which becomes pale on cooling. It is very rare, having been found only at Finbo and Broddbo, near Fahlun, in Sweden, where it occurs imbedded in quartz and albite, accompanying pyrophyssalite and orthite.

2. Fluater of Cerium, with excess of base. Colour yellow, resembling porcelain jasper, with very slight traces of crystallization. It contains twice as much of the oxides of cerium as the preceding substance, although its comportment before the blowpipe is nearly similar. If heated alone on charcoal it becomes black at an incipient redness, but assumes on cooling, successively dark brown, red, and orange tints. It is found accompanying the compact black Allanite, in very small quantities, at Bastness in Sweden.

3. Fluater of Yttria and Cerium. This is an earthy mineral, found at Finbo in Sweden, in masses which seldom exceed the magnitude of a pea. Its colour is pale red, but it also occurs deep red, yellow, and even white; it is very soft, and may be easily scratched with the nail. According to Berzelius, it is a mechanical mixture of the fluater of yttria with fluater of cerium and silica. It presents nearly the same re-actions as the Neutral Fluater.\*

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\* The above is taken from the Appendix to Haidinger's translation of Mohs; a more perfect mineralogical description is a desideratum.



## PHOSPHATE OF YTTRIA.

Brewster's Jour. Vol. III. 227. Phosphorsaure Yttererde of the Germans.

Sp. Gr. 4.5—4.6. H. = 4.5—5.0.

Pyramidal. FIG. 64. Inclination of P to P over *l* about 90°. Colour yellowish-brown. Opake. Lustre resinous. Streak pale brown. Cleavage perfect, parallel to *l*. Fracture uneven and splintery. Its constituents, according to the analysis of Berzelius, are, yttria 62.58, phosphoric acid with a little fluoric 33.49, subphosphate of iron 3.93. Before the blowpipe it comports itself like phosphate of lime, but is distinguished from that mineral by its infusibility without addition. With borax it affords a colourless bead, which becomes milky on cooling; and with boric acid and a piece of iron wire yields phosphuret of iron. It is not soluble even in concentrated acids.

## OBSERVATIONS.

The phosphate of yttria was discovered by Mr Tank of Frederickshal, at Lindenaes in Norway, in a vein consisting chiefly of coarse-grained granite.

## STROMNITE.

Barystrontianite, P. Traill, Royal Society Trans. Vol. IX. p. 81.

Sp. Gr. 3.7. H. = 3.5.

Occurs massive, but with a crystalline structure. Colour yellowish-white internally in the fresh fracture, approaching to grey externally, where it appears disintegrated. Lustre inclining to pearly, but faint. Externally opake, but translucent on the edges, and brittle. Contains carbonate of strontia 68.6, sulphate of baryta 27.5, carbonate of lime 2.6, oxide of iron 0.1—Traill. It effervesces briskly with acids, and is partly dissolved; but is infusible before the blowpipe.

## OBSERVATIONS.

It was distinguished and described by Dr Traill, who found it in veins along with galena and barytes, in a kind of clay slate, at Stromness in Orkney, and named it from its locality. The appellation of barystrontianite is derived from its composition.

## PHOSPHATE OF IRON AND MANGANESE.

Phosphat of Manganese, Pitchy Iron Ore, *J.* Phosphate of Manganese, *P.* Phosphorsäures Mangan of the Germans. Phosphormangan, *W.* Manganese Phosphatée Ferrifère, *H.*

Sp. Gr. 3·4—3·8. H. = 5·0.

Occurs massive, of a blackish-brown colour, opaque in the mass, but translucent on the edges. *Lustre* resinous, inclining to adamantine. *Streak* yellowish-grey. *Cleavage* in three directions perpendicular to each other, one of them more distinct than the others. *Fracture* small conchoidal. Consists of

Vauquelin.		Berzelius.	
Oxide of iron	31·0	Protoxide of mangan.	32·6
Ox. of manganese	42·0	Phosphoric acid	32·8
Phosphoric acid	27·0	Protoxide of iron	31·9
		Phosphate of lime	3·2

Before the blowpipe it fuses, with a brisk intumescence, into a black scoria, which is magnetic ; and in nitric acid dissolves readily without effervescing.

## OBSERVATIONS.

This mineral occurs near Limoges in France, in a vein of quartz traversing granite, accompanied by the large coarse variety of beryl peculiar to that locality.



## ORDER KERATE.\*

### CHLORIDE OF SILVER.

Hexahedral Pearl-Kerate, *M.* Hexahedral Corneous Silver, *[J.]* Muriate of Silver,  
Horn Silver, *P. Hornerz, W. Hoff:* Hornsilber, *⁵Haus.* Silberhornerz, *L.* Argent  
Muriaté, *H.*

Sp. Gr. 5·5—5·6. H. = 1·0—1·5.

Tessular. FIG. 8. General form the cube. *Colour* pearl grey, passing into blue or green, which on exposure to light becomes brown. Feebly translucent. *Lustre* resinous, passing into adamantine. *Streak* shining. *Cleavage* none, but *fracture* conchoidal. Yields to the nail, is malleable and sectile. Klaproth found in a variety from Saxony, and another from Peru,

Silver	67·75	76·0
Chlorine	21·5	24·0
Oxide of iron	6·00	0·0
Alumina	1·75	0·0
Sulphuric acid	0·25	0·0

It melts in the flame of a candle, and emits fumes of muriatic acid. Before the blowpipe it may be reduced to a metallic globule, and when rubbed with a piece of moistened zinc or iron, it is decomposed, and the surface becomes covered with a thin film of metallic silver. It is insoluble in nitric acid or water.

#### OBSERVATIONS.

This rare mineral occurs in veins chiefly in primitive rocks, accompanying other ores of silver, and, what is remarkable, is found only in the higher parts of these veins. The largest masses, and particularly those of a green colour, are brought from Peru and Mexico. It used to be found in considerable quantities in the Saxon mining districts of Johann-georgenstadt and Freyberg, but is now very rare; the Zwinger col-

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\* From the Greek *κερας*, *horn*, such being the general aspect of the order.

lection at Dresden contains a mass from Johanngeorgenstadt, weighing  $6\frac{3}{4}$  lb. It also occurs in Siberia, in Cornwall, and at Huelgoet in Brittany, and, when in sufficient quantity, is valuable as an ore of silver. The *Buttermilcherz* of the Germans, from Andreasberg in the Hartz, is considered an earthy variety of this species; it contains, according to Klaproth, silver 24.64, muriatic acid 8.28, alumina 67.08, and seems therefore to be a muriate of silver in combination with a small portion of muriate of alumina.

### MURIATE OF MERCURY.

Pyramidal Pearl Kerate, *M.* Pyramidal Corneous Mercury, *J.* Muriate of Mercury, Horn Quicksilver, *P.* Quecksilber-Hornerz, *W.* and *L.* Hornquecksilber, *Haus.* Kalomel, *Haid.* Mercure Muriaté, *H.*

Sp. Gr. 6.4—6.5. H. = 1.5—2.0.

Pyramidal. FIG. 65. Inclination of P to P =  $98^{\circ} 4'$ , of P to P' =  $136^{\circ}$ . Colour greyish-white or yellowish. Sometimes translucent. Lustre adamantine. Streak white. Cleavage parallel to *l*, but very indistinct. Fracture perfect conchoidal. Sec-tile. Klaproth found it to consist of

Oxide of mercury	76.0
Muriatic acid	16.4
Sulphuric acid	7.6

which appears incorrect, the chemical formula indicating oxide of mercury 88.48, muriatic acid 11.52. Before the blowpipe, on charcoal, it is entirely volatilized if pure, which serves at once to distinguish it from the foregoing species.

### OBSERVATIONS.

The muriate of mercury is of even rarer occurrence than the chloride of silver. Its chief locality is Moschellandsberg in Deuxponts, where the crystals are often large and well defined, coating the cavities of a ferruginous gangue, and associated with cinnabar; but it is also met with in the quicksilver mines of Idria in Carniola, at Almaden in Spain, and at Horzowitz in Bohemia.



## ORDER TERENE.

### BLACK COBALT OCHRE.

Earthy Cobalt, *P.* Schwartzter Erzkobalt, *Haid.* Erzkobold, *W.* Cobalt Oxidé Noir, *H.*

Sp. Gr. 2·24. Soft.

Massive, botryoidal, earthy, and granular. *Colour* bluish-and brownish-black. *Opake*, with a somewhat resinous lustre, and shining streak. *Sectile*. It consists, according to Dobereiner, of the oxides of cobalt and manganese, with 23 per cent. of water. Before the blowpipe it gives out an arsenical odour, but does not melt; and to glass of borax communicates a smalt-blue colour.

#### OBSERVATIONS.

At Alderley Edge in Cheshire, it occurs in sandstone accompanying lead and copper; at Nertschinsk in Siberia, with green carbonate of copper; and at Riechelsdorf in Hessa, and Saalfeld in Thuringia, associated with several species of cobalt pyrites. Its only use is in the fabrication of smalt. The brilliancy which its surface attains when streaked with, or rubbed against a hard body, is perfectly characteristic.

### KUPFERINDIG.

Sp. Gr. 3·8—3·82. H. about 2·0.

Massive; in spheroidal shapes, with a crystalline surface. *Colour* indigo-blue, or darker. *Opake*. *Lustre* resinous, though faint. *Streak* lead-grey and shining. *Sectile*. Before the blowpipe it burns, prior to becoming red hot, with a blue flame, and melts into a globule, which is strongly agitated, and emits sparks; finally it yields a button of copper. It contains copper 64·77, sulphur 32·64, lead 1·05, iron 0·46—Walchner.

#### OBSERVATIONS.

It occurs at Sangerhausen in Thuringia, imbedded in grauwacke, and is a very rare mineral.

## CUPREOUS MANGANESE.

Kupfermangan of the Germans.

Sp. Gr. 3·15—3·25. H. about 1·5.

Massive, in small reniform and botryoidal groups. *Colour* bluish-black. *Opake*. *Lustre* resinous. *Streak* corresponding to the colour. Not brittle. Consists of black oxide of manganese 82·00, brown oxide of copper 13·50, silica 2·00—Lampadius. Berzelius found also a considerable quantity of water. Before the blowpipe it becomes brown, but is infusible; to borax and salt of phosphorus it communicates amethystine and green colours, and the other characteristic indications of copper and manganese.

## OBSERVATIONS.

This very rare mineral was distinguished by Breithaupt and Lampadius. It occurs in the tin mines of Schlaggenwald in Bohemia.

## WAD.

Earthy Manganese, P.

Sp. Gr. 3·7. H. about 0·5.

Occurs in reniform, botryoidal, and arborescent shapes, in froth-like coatings on other minerals; also massive. *Colour* brown or black. *Streak* the same. *Opake*. *Fracture* earthy. Very sectile. Yields to the nail, and soils the fingers. Contains, oxide of manganese 68·0, oxide of iron 6·5, water 17·5, carbon 1·0, baryta and silica 9·0—Klaproth. Heated in the matrass, it gives off much water, and is considered by Berzelius a hydrate of manganese. When mixed with linseed oil it undergoes spontaneous combustion.

## OBSERVATIONS.

Although the specific gravity of this substance is as high as 3·7, the varieties seem very light when taken in the hand; their property of imbibing water with facility, and sinking as soon as immersed in it, accounts for this, and therefore those descriptions of its specific gravity which state it as being below 1·0 must be erroneous. The localities of wad are principally the manganese pits near Exeter in Devonshire, Cornwall, the Hartz, and Piedmont. It is supposed to afford the colouring matter in the dendritic delineations upon limestone, steatite, and other substances.



## PYRORTHITE.

Pyrorthit, *Berzelius*.

Sp. Gr. 2.15—2.25. H. under 3.0.

In long thin imbedded crystals without any distinct form. *Colour* brownish-black, or, if weathered, yellowish-brown. *Opake*. *Lustre* resinous. *Streak* corresponding to the colour. Consists of silica 10.43, alumina 3.59, protoxide of cerium 13.92, protoxide of iron 6.08, yttria 4.87, lime 1.81, protoxide of manganese 1.39, water 26.50, carbon 31.41—*Berzelius*. On exposure to a gentle heat it takes fire (hence the name of *Pyr-orthite*), and burns without flame or smoke; afterwards it becomes white, and melts into a black enamel. It gives a transparent glass with borax; and is soluble in heated acids, with the exception of a black powder.

## OBSERVATIONS.

It is found in a vein of granite traversing gneiss, at Karafvet, near Fahlun, in Sweden, accompanied with gadolinite; and, except that it is devoid of lustre, bears much resemblance to the orthite from the same vicinity.

## HISINGERITE.

Hisingerit, *Berzelius*.

Sp. Gr. 3.0—3.1. Soft.

Massive. *Colour* black and opake. *Streak* greenish-grey. *Cleavage* distinct in one direction. Cross fracture earthy. *Sec-tile*. Consists of

Oxide of iron	51.50
Silica	27.50
Alumina	5.50
Oxide of manganese	0.77
Volatile substances	11.75— <i>Berzelius</i> .

If gently heated before the blowpipe it becomes magnetic, but at an increased temperature melts into a dull opake black globule, and yields with borax a yellowish-green glass.

## OBSERVATIONS.

It occurs in the cavities of calcareous spar, in the parish of Svärta in Sudermanland, Sweden; but, from its extreme rarity, is as yet a mineral very little known.

## GRAPHITE.

Rhomboidal Graphite, *J.* Plumbago, Black Lead, *P.* Graphit, *W.* and *L.* Fer Carburé, *H.*

Sp. Gr. 1·8—2·1.  $H. = 1·0—2·0$ .

Sometimes, though rarely, in flat six-sided tables, having their summits striated parallel to three of their edges; commonly in kidney-shaped masses, or disseminated in rocks. *Colour* iron or steel grey. *Opake*, with metallic lustre and black shining streak. *Cleavage* perfect, parallel to the terminal face of the prism. *Sectile*, and the thin laminæ very flexible. Feels greasy, and leaves traces on paper. Consists of

Carbon	92·0	90·0
Iron	8·0 Vauquelin.	9·1—Berthollet.

When exposed to a high temperature, it burns without flame or smoke, leaving a portion of red oxide of iron. It is infusible before the blowpipe, and is not affected by the addition of any re-agent.

## OBSERVATIONS.

It occurs usually in beds, or in masses imbedded in granite, gneiss, mica-slate, and grauwacke; also in the coal formation. The purest and most esteemed specimens come from Borrowdale in Cumberland, where it occurs in rocks, consisting chiefly of grauwacke, and whence it is excavated to considerable extent for the manufacture of pencils. It is met with crystallized at Pargas in Finland; in scales like mica at Arendal in Norway; forming irregular masses imbedded with particles of garnet in gneiss at Glenstrathfarrar, near Beaully in Inverness-shire; in the coal formation at Craigman in Ayrshire; at Passau in Austria; in Ceylon, and many other places. That from the coal formation appears to have been produced by the action of greenstone on the coal, presenting a charred aspect and columnar disposition, extremely loose and porous; this passes into beds of a more compact nature, in whose cross fracture traces of the columnar disposition are still observable.

For making pencils, it is sliced, by means of fine saws, into thin quadrangular strips, and then inserted into grooves cut in half cylinders of cedar. The powder too which necessarily arises from this process of sawing is used in the fabrication of inferior kinds of pencil, being for that purpose previously mixed up with sulphur and gum. Every manufacturer is aware of the different degrees of hardness which the graphite possesses, and takes advantage of that peculiarity in making the harder or softer kinds of pencil. Besides its utility in this way, it is largely employed in the manufacture of crucibles, particularly such as



are used for the purposes of the mint, as they sustain more intense heat, and are esteemed for their tenacity and expansibility. Graphite is likewise used for giving a gloss to iron stoves and railings, and for diminishing the friction in machinery.

This mineral derives its name from the Greek *γραφω*, *I write*, in allusion to its quality of leaving traces on paper; but as the sulphuret of molybdena, which closely resembles it in many respects, also possesses the quality of marking white surfaces, it should be observed, that if both be rubbed on a piece of porcelain-biscuit, the streak made by the graphite will appear metallic, while that of the molybdena has a dull-greenish tinge. In the same way it may be distinguished from black crayon, which possesses a dull-black streak.

The name of "Black Lead," which is frequently applied to this mineral, is preposterous, as there is not an atom of lead in its composition, and the retention of such names only tends to create confusion.

### IRON SINTER.

Pitchy Iron Ore, *P.* Eisensinter, Eisenpecherz, *W.* Fer Oxidé Résinite, *H.* Pittizite, *Levy.*

Sp. Gr. 2.2—2.4. H. = 2.5.

Reniform; stalactitic; massive; having much the aspect of resin. *Colour* yellowish-, reddish-, or blackish-brown. Transparent or translucent, with a brilliant vitreous *lustre*, and conchoidal *fracture*. *Streak* pale olive-green or lemon yellow. Brittle. Consists of

	Saxony.	Freyberg.
Oxide of iron	33.46	40.45
Arsenic acid	26.06	30.25
Sulphuric acid	10.75	0.00
Protoxide of manganese	0.59	0.00
Water	28.48—Strom.	28.50—Kersten.

Before the blowpipe *per se* it instantly becomes opaque and cracks, some varieties emitting a strong arsenical odour, during which they are partly volatilized. At an increased temperature it fuses into a black enamel, and on charcoal becomes magnetic. In the matrass it gives off water profusely.

### OBSERVATIONS.

It is found in the galleries of several old mines, as at Freiberg and Schneeberg in Saxony, at Pless in Upper Silesia, and in the district of Choco in Chili. It is supposed to be formed from the decomposition of iron pyrites, and bears much analogy to the arseniate of iron (page 76), of which it seems to be a massive variety.

## CHRYSOCOLLA.

Uncleavable Staphyline Malachite, *M.* Common Copper-Green or Chrysocolla,  
 Uncleavable Copper Green, *J.* Kupfergrun, Eisenchussig Kupfergrun, *Wern.*  
 Kieselmalachit, *Haus.* Kieselkupfer, *L.* Cuivre Hydraté Siliceux, *H.*

Sp. Gr. 2.0—2.2. H. = 2.0—3.0.

Botryoidal and massive. *Colour* emerald and pistachio-green, passing into sky-blue. Translucent on the edges. *Streak* white. *Cleavage* none. *Fracture* conchoidal and shining. Rather sectile. Contains

Oxide of copper	50.0	49.63
Silica	26.0	28.37
Water	17.0	17.50
Carbonic acid	7.0	3.00
Sulphate of lime	0.0—Klaproth.	1.50—John.

Before the blowpipe, on charcoal, it blackens in the oxidating, and reddens in the interior flame, but does not melt; with borax it fuses into a green glassy globule, and is partly reduced, as may be seen by the metallic particles which this globule contains. If pure, it is soluble without effervescence in nitric acid, and leaves a residue of silica.

## OBSERVATIONS.

This mineral varies much in appearance, the same specimen sometimes bearing at one end the character of an earthy decomposed felspar, which passes by insensible degrees towards the other, into brittle, translucent, green chrysocolla. The *Copper Green* and *Iron-shot Copper Green*, however, into which the varieties have been divided, differ in nothing but the greater or less purity of their substance. When the colour inclines to brown the mineral is impure. It is usually found accompanying other ores of copper, as in Cornwall, at Libethen in Hungary, at Falkenstein and Schwatz in the Tyrol, in Siberia, the Bannat, Thuringia, and other places on the continent; also at Somerville in New Jersey, and in many of the mining districts of Chili.

## GANSEKOTHIG-ERZ.

H. = 2.0 — 3.0.

Mamillated. *Colour* yellow or pale green. Translucent. Shining, with white *streak*, resinous *lustre*, and conchoidal *fracture*. Sometimes earthy, and mixed with cobalt. Before the blowpipe it gives off copious fumes of arsenic, and fuses into



a blackish scoria ; when the heat is continued on charcoal it melts, diminishes in bulk, and yields a button of silver, but the slag contains metallic iron, which strongly affects the magnet. The gansekothig-erz hence appears to be an arseniate of silver and iron.

## OBSERVATIONS.

Occurs principally at the mines of Clausthal in the Hartz, where, when obtained in sufficient quantity, it is highly prized as an ore of silver. Is met with also in Cornwall, and at Allemont in Dauphiné. This is not a very interesting species, except to the Hartz collectors, in some of whose cabinets I have seen drawers filled with it. The German name is derived from its peculiar colour.

## ALLOPHANE.

Sp. Gr. 1·8—1·9. H. = 3·0.

Reniform and massive. Of a pale-blue, green, or brown colour. Translucent, with a vitreous or resinous lustre, and white streak. *Fracture* conchoidal and shining. Consists of

Black Forest.

Alumina	32·20	38·76
Silica	21·92	24·11
Carbonate of copper	3·06	0·00
Oxide of copper	0·00	2·33
Hydrate of iron	0·28	0·00
Water	41·30—Strom.	35·75—Walchner.

with a small portion of lime and sulphuric acid. Before the blowpipe it intumesces and falls into a powder without fusing, communicating at same time a green tinge to the flame ; but with borax melts readily into a transparent colourless glass. In acid it gelatinizes.

## OBSERVATIONS.

This mineral was first described by Stromeyer. It is found at Saalfeld in Thuringia, at Gersbach in the Black Forest, in the Upper Palatinate, at Schneeberg in Saxony, and in other places. It has been also called *Riemannite*.

## HALLOYSITE.

Berthier, Ann. de Chimie, xxxii. p. 334.

Sp. Gr. 1·8—2·1.

Compact, having the aspect of steatite. Colour white, generally with a slightly bluish tint. Translucent on the edges.

*Fracture* conchoidal, like that of wax. Imbibes water. Adheres to the tongue. Yields to the nail, and is polished by it. When exposed to a high temperature it loses in weight, but acquires much hardness, and its colour becomes milk white. It consists, according to Berthier, of silica 39·5, alumina 34·0, water 26·5. Sulphuric acid decomposes it readily, dissolving the alumina, and leaving the silica in a gelatinous state.

## OBSERVATIONS.

This hydro-silicate of alumine occurs in compact amorphous masses, sometimes larger than the first, along with ores of zinc, iron, and lead, in the vicinity of Liege and Namur. It was described as a new species by Berthier, and named by him in honour of his uncle M. Omalius d'Halloy, who first noticed it.

The *Lenzenite* of John, from Kall in the Eifel, in Prussia; the *Severite* of Dufour, from St Sever in France; and the *Pholerite*, presenting soft nacreous scales of a white colour, from the coal formation of Fins in the Dep. of Allier in France, and described in the *Ann. des Mines*, xi. 489, are similar compounds, and most probably mere varieties of this species.

## KOLLYRITE.

Kollyrite, P. Alumine hydrate silicifere, *Levy*.

Massive; having the appearance of clay. Cuts easily with the knife. *Colour* white. Translucent or opaque. *Lustre* vitreous at the fracture. *Fracture* earthy. Contains

Alumina	45·0	44·5
Silica	14·0	15·0
Water	40·0—Klaproth.	40·5—Berthier.

Dissolves without effervescence in nitric acid, but is not affected by the blowpipe. When calcined, gives off much water, separates into columnar masses like starch, and loses weight. Absorbs water with a slight noise, and becomes partly transparent.

## OBSERVATIONS.

It is met with at Schemnitz in Hungary, and on the Oo river in the Pyrenees.



## ORDER MALACHITE.

### LENTICULAR ARSENIATE OF COPPER.

Prismatic Lirocone Malachite, *M.* Di-prismatic Olivenite or Lenticular Copper, Prismatic Liriconite, *J.* Octahedral Arseniate of Copper, *P.* Linsenerz, *W.* and *L.* Linsenkupfer, *Haus.* Cuivre Arseniaté Primitif, Cuivre Arseniaté Octaédral, *Levy.* Cuivre Arséniaté Octaèdre Obtus, *H.*

Sp. Gr. 2·8—3·0. H. = 2·0—2·5.

Prismatic. FIG. 66. Inclination of *o* to *o* =  $71^{\circ} 59'$ , of *d* to *d* =  $119^{\circ} 45'$ , being the only form yet observed in this substance. Its colour varies from sky-blue and smalt-blue, to deep grass- or verdigris-green. Translucent. *Lustre* vitreous, inclining to resinous. *Streak* corresponding to the colour, but paler. *Cleavage* parallel to the face *d*, though not very perfect. Consists of

Oxide of copper	49
Arsenic acid	14
Water	35—Chenevix.

It loses both colour and transparency before the blowpipe, emits fumes of arsenic, and is changed into a black friable scoria, containing some white metallic globules. With borax it affords a green globule, and is partly reduced; and in nitric acid is soluble without effervescence.

#### OBSERVATIONS.

In the splendid collection of Cornish minerals belonging to Mr Rashleigh of Menabilly, there is a perfect crystal of this substance measuring an inch in diameter. In general, however, the individuals are much smaller, occurring with various ores of copper, pyrites, and quartz, at the adjacent mines of Huel Gorland and Huel Unity in Cornwall. It is likewise met with in minute crystals at Herrenggrund in Hungary, but on the continent is very rare.

## ARSENATE OF IRON.

Hexahedral Lirocone Malachite, *M.* Hexahedral Olivenite or Cube Ore, Hexahedral Liriconite, *J.* Wurfelerz, *W.* Pharmakosiderit, *Haus.* Arseniksaures Eisin, *L.* Fer Arseniaté, *H.*

Sp. Gr. 2.9—3.0. H. = 2.5.

Tessular. FIG. 67. Occurs crystallized in cubes, either perfect, or having the alternate angles replaced by one or more planes; rarely massive. Colour olive-green, passing into yellowish-brown. Translucent. Streak pale olive-green or brown. Lustre adamantine. Cleavage parallel to the planes of the cube, though indistinct. Surface often streaked diagonally. Sometimes partially decomposed. Consists of

Oxide of iron	45.5	40.56
Arsenic acid	31.0	38.00
Oxide of copper	9.0	0.60
Silica	4.0	0.35
Water	10.5—Chenevix.	19.57—Berzelius.

Before the blowpipe on charcoal it emits copious fumes of arsenic, and melts in the reducing flame into a metallic scoria, which acts upon the magnet. In the flame of a candle it turns red, and fuses into a globule presenting a brilliant metallic lustre. It becomes electric when heated.

## OBSERVATIONS.

The arseniate of iron occurs in the mines of Huel Gorland, Huel Unity, and Carharrak, in Cornwall, coating cavities of quartz, and associated with several of the ores of copper; also at St Leonhard in France, and at Schneeberg and Schwarzenberg in Saxony, though, like the last species, it is comparatively a rare mineral on the continent.

The Iron Sinter, in chemical composition, comportment before the blowpipe, streak, hardness, and most other characters, appears to be closely allied to this species.

## ACICULAR ARSENATE OF COPPER.

Prismatic Olive Malachite, *M.* Acicular Olivenite, *J.* Prismatic Arseniate of Copper, *Bournon.* Right Prismatic Arseniate of Copper, *P.* Olivenerz, *W.* Olivenkupfer, *Haus.* Olivenit, *L.* Cuivre Arseniaté Octaèdre Aigu, *H.*

Sp. Gr. 4.2—4.6. H. = 3.0.

Prismatic. FIG. 58. Inclination of M to M over the apex =  $110^{\circ} 50'$ , of *d* to *d* over P =  $92^{\circ} 30'$ . Colour olive-green,



pistachio-green, and blackish-green, passing into liver-brown and wood-brown; the fibrous variety siskin-green. Semi-transparent. Opake. *Lustre* adamantine. *Streak* olive-green or brown. Traces of *cleavage* parallel to M and d. *Fracture* conchoidal, and uneven. Consists of

Oxide of copper	50.62	50.0
Arsenic acid	45.00	29.0
Water	3.50—Klaproth.	21.0—Chenevix.

Remains unchanged before the blowpipe, but fuses upon charcoal with a kind of deflagration, and is reduced, forming a white metallic globule, which, in the progress of cooling, becomes covered with a red scoria. It is soluble in nitric acid.

## OBSERVATIONS.

The crystallized varieties of this mineral are generally of a darker green colour than the fibrous or radiated ones. They occur disposed on, or coating cavities of quartz, and are almost peculiar to the copper mines of Cornwall. Latterly it has also been discovered at Alston Moor, though not in such fine specimens as in Cornwall. One of the most beautiful varieties of the acicular arseniate of copper is that to which the name of *Wood Arseniate* has been applied. This is said to contain a larger proportion of arsenic acid, and generally presents a soft velvet-like surface of a light siskin or greenish-grey colour, having an earthy texture, and a radiated or fibrous structure; it is also peculiar to Cornwall.

The substance denominated *Condurrite* by Mr Phillips (Ann. of Phil. Oct. 1827), from Condurrow mine in Cornwall, appears closely to resemble the present species. It occurs massive, is of a brownish-black colour, yields to the knife which leaves a polished metallic-like surface, and on exposure, cracks in all directions into irregular portions resembling starch. Its comportment before the blowpipe is the same, and its chemical composition is very analogous to that of the arseniate of copper. According to Faraday, it contains copper 60.50, sulphur 3.06, arsenic 1.51, arsenious acid 25.94, water 8.99. It seems to be a mere mechanical deposit.

## PHOSPHATE OF COPPER.

Di-prismatic Olive Malachite, *M.* Prismatic Olivenite, *J.* Phosphate of Copper, *P.* Olivenerz (in part), *W.* Blattriger Pseudomalachit (in part), *Haus.* Phosphorsaures Kupfer, *L.* Phosphorkupfer von Libethen, *Haid.* Cuivre Phosphaté, *H.*

Sp. Gr. 3.6—3.8. H. = 4.0.

Prismatic. FIG. 68. Inclination of *o* to *o* over the apex =  $111^{\circ} 58'$ , of *u* to *u* =  $95^{\circ} 2'$ . Colour olive-green, generally dark. Translucent on the edges. *Lustre* resinous. *Streak*

olive-green. *Cleavage* parallel to *o* and *u*, indistinct. *Fracture* conchoidal. *Surface* generally uneven. It consists of

Oxide of copper	63.9
Phosphoric acid	28.7
Water	8.4—Berthier.

It dissolves without effervescence in nitric acid, and before the blowpipe fuses into a brownish-black globule, the centre of which is composed of metallic copper.

## OBSERVATIONS.

This species has generally been classified either with the preceding arseniate of copper, or with the hydrous phosphate of copper (page 80). Its hardness and specific gravity, however, are quite sufficient to distinguish it from both. Its crystals do not admit of very accurate measurement, in consequence of the faces being frequently curved. It occurs in quartzose cavities, associated with copper pyrites, at Libethen, near Neusohl in Hungary; also in small quantities at Gunnislake in Cornwall.

## BLUE CARBONATE OF COPPER.

Prismatic Azure Malachite, *M.* Blue Copper or Prismatic Malachite, Prismatic Blue Malachite, *J.* Kupferlasur, *W.* Kohlensaures Kupfer (in part), *L.* Cuivre Carbonaté Bleu, *H.* Lasur-Malachit, *Haid.*

Sp. Gr. 3.7—3.9. H. = 3.5—4.0.

Hemi-prismatic. FIG. 70. Inclination of *s* to *h* =  $92^{\circ} 21'$ , of *a* to *h* =  $132^{\circ} 43'$ , of *M* to *M* over *s* =  $99^{\circ} 32'$ . Colour azure-blue, passing into blackish-and Berlin-blue. Translucent or opaque. Lustre vitreous, or adamantine. Streak somewhat lighter than the colour. Fracture conchoidal. Contains,

Copper	56.0	56.0
Oxygen	14.0	12.5
Carbonic acid	24.0	25.0
Water	6.0—Klaproth.	6.5—Vauquelin.

It is soluble with effervescence in nitric acid, becomes black when strongly heated, fuses upon charcoal before the blowpipe, and colours glass of borax green in the oxidating flame.

## OBSERVATIONS.

Some of the crystalline forms of this species are extremely complicated. It occurs in the veins of primitive and secondary mountains, associated chiefly with green carbonate and red oxide of copper. At Chessy near Lyons, the crystals assume such variety of form, present such brilliant colours, and the specimens at same time are so numerous, that its best



known trivial name, that of *Chessy Copper*, has arisen from this circumstance. Very fine crystals occur in Siberia, while those from Moldawa in the Bannat, though of smaller size, are often extremely distinct. Wheal Buller, near Redruth in Cornwall, has also afforded some fine crystallized varieties; and at Alston-moor and Wanlockhead small quantities are occasionally met with. It is found massive and of a smalt-blue colour in Cornwall; compact and earthy, the *earthy blue copper* of Jameson, in Siberia and Thuringia; and in amorphous rounded concretions, sometimes of considerable dimensions, at Chessy.

When obtained in sufficient quantity it is a valuable ore of copper. If ground to impalpable powder, it forms a blue paint of very bright tint, paler than the crystallized mineral; this, however, being apt to lose its original hue and turn green, is of no great value.

## DIOPTASE.

Rhombohedral Emerald Malachite, *M.* Rhombohedral Emerald Copper or Dioptase, Rhomboidal Emerald-Malachite, *J.* Emerald Copper, *P.* Kupfersmaragd, *W.* and *L.* Dioptas, *Haus.* Cuivre Dioptase, *H.*

Sp. Gr. 3·2—3·4. H. = 5·0.

Rhombohedral. FIG. 71. Inclination of  $r$  to  $r = 95^\circ 48'$ . Colour fine emerald green. Transparent or translucent, with a shining vitreous lustre. Streak green. Cleavage perfect parallel to  $r$ . Fracture conchoidal. Contains,

Oxide of copper	55·0	45·45
Silica	33·0	43·18
Water	12·0—Lowitz.	11·36—Vauquelin.

It decrepitates before the blowpipe, tinging the flame yellowish-green, and becomes black in the exterior, and red in the reducing flame, but does not melt. It fuses in glass of borax, imparting to the globule a green tinge, and is ultimately reduced. Nitric acid has no effect upon it even when heated, but it is soluble without effervescence in muriatic acid.

## OBSERVATIONS.

Dioptase (from *διοπτουμαι*, *perspicio*, in allusion to the possibility of seeing the natural joints by transmitted light) occurs in the Kirghese steppes of Siberia. It was only known, in this country at least, in detached single crystals similar to fig. 71, until Mengé's visit to Siberia in 1828, since which we have had it presenting several different combinations, disposed on quartz in small but numerous well-defined individuals. It was first brought from Siberia by Achir Mamed, a Bucharian merchant, who endeavoured to dispose of it as emerald, and after whom it received the name of *Achirite*. Philips also mentions it from Rezbanya in Hungary. It acquires

by friction, when insulated, negative electricity, which, together with its inferior hardness and higher specific gravity, serves to distinguish it from emerald.

### EUCHROITE.

Prismatic Emerald Malachite, *M.* Euchroite, *Breithaupt.*

Sp. Gr. 3.35—3.45. H. = 3.5—4.0.

Prismatic. FIG. 72. Inclination of  $n$  to  $n$  over  $P = 87^\circ 52'$ , of  $M$  to  $M = 117^\circ 20'$ . Colour bright emerald-green. Transparent, with vitreous lustre, and considerable double refraction. Streak pale apple-green. Cleavage indistinct. Fracture uneven. Consists, according to Turner, of peroxide of copper 47.65, arsenic acid 33.02, water 18.80. In the matrass it loses its water, changes its colour, and becomes friable. When heated upon charcoal to a certain point, it is reduced in an instant with a kind of deflagration, leaving a globule of malleable copper with white metallic particles disposed through it, which are crystallized on continuing the blast. It dissolves readily in nitric acid without effervescence, even on the application of heat.

#### OBSERVATIONS.

This mineral (named from *ευχροια*, *pulcher color*) was discovered at Libethen in Hungary in quartzose mica slate, and brought to London under the name of euchroite. It occurs in crystals of considerable size, and bears no small resemblance to the last species. Only a very few specimens of it are known, one of which is preserved in the collection at Lauriston.

### HYDROUS-PHOSPHATE OF COPPER.

Prismatic Habroneme Malachite, *M.* Prismatic Olivenite or Phosphate of Copper, Prismatic Green Malachite, *J.* Hydrous Phosphate of Copper, *P.* Phosphor Kupfererz (in part), *W.* Pseudomalachit, *Haus.* Phosphorsaures Kupfer (in part), *L.* Cuivre Phosphate (in part), *H.* Phosphor Kupfer von Rheinbreitbach, *Haid.*

Sp. Gr. 4.2—4.3. H. = 5.0.

Hemi-prismatic. FIG. 73. Inclination of  $P$  to  $P = 117^\circ 49'$ ; of  $f$  to  $f = 141^\circ 4'$ . Colour emerald-green or blackish-green, often darker on the surface, and lighter when in mass. Translucent, generally on the edges only. Lustre adamantine, inclining to vitreous. Streak a little paler than the colour. Contains oxide of copper 62.85, phosphoric acid 21.68, water



15·45—Lunn. It fuses easily before the blowpipe, and is converted into a vesicular metalloidal globule. It is soluble without effervescence in nitric acid, particularly if heated.

## OBSERVATIONS.

As this mineral generally presents itself either aggregated in extremely minute individuals, or mamillated and compact, its crystalline form was long the subject of discussion; the specimens from Rheinbreitenbach, near Bonn, on the Rhine, where they occur in veins traversing grauwacke-slate, and accompanied by quartz and ores of copper, have, however, decided that point. At Libethen in Hungary the massive variety only is met with.

## GREEN CARBONATE OF COPPER.

Hemi-prismatic Habroneme Malachite, *M.* Di-prismatic Green Malachite, *J.* Green Carbonate of Copper, *P.* Malachit, *W.* and *Haus.* Kohlensaures Kupfer (in part), *L.* Cuivre Carbonaté Vert, *H.*

Sp. Gr. 3·6—4·0. H. = 3·5—4·0.

Hemi-prismatic. FIG. 74. Inclination of P to P contiguous in the twin crystals =  $123^{\circ} 38'$ , of M to M over *s* =  $103^{\circ} 42'$ . Colour green. Transparent or translucent, sometimes only on the edges. Lustre adamantine, inclining to vitreous. Streak green, rather paler than the colour. Cleavage highly perfect parallel to P, as also to a face which replaces the edge *x* in a direction perpendicular to P. Brittle. Contains

	Siberia.	Chessy.
Copper	58·0	56·10
Oxygen	12·5	14·00
Carbonic acid	18·0	21·25
Water	11·5—Klaproth.	8·75—Vauquelin.

Before the blowpipe it decrepitates, becomes black, and is partly infusible, partly converted into a black scoria. It melts readily with borax, imparts to it a deep-green colour, and yields a globule of metallic copper. It is entirely soluble in nitric acid.

## OBSERVATIONS.

The *fibrous* and *massive* into which this species has been divided is not a distinction of any consequence, for the one often runs so insensibly into the other, that it is difficult to say to which of them a specimen should be referred. The crystallized variety is extremely rare, having been observed only in minute transparent twins, coating the cavities of the more fibrous kinds. Exteriorly it assumes globular, reniform, botryoidal,

and stalactitic shapes, and occurs in the same repositories as the blue carbonate of copper. Beautiful specimens of the fibrous variety are found in Siberia, at Chessy in France, and in the old mine at Sand-lodge in Shetland, disseminated in iron ore at Moldawa in the Bannat. The compact Malachite is chiefly known from Schwatz in the Tyrol; it also occurs in small quantities accompanying the blue carbonate in Cornwall, Wales, Ireland, and elsewhere. It is a valuable ore of copper, and, from its variegated colours, and the brilliant polish of which it is susceptible, is prized by the lapidary for ornamental purposes. Such varieties as are sufficiently compact are cut into vases, snuff-boxes, &c.; and in St Petersburg it is made up into tables, and other magnificent articles of luxury. For this purpose, as the malachite rarely occurs in masses exceeding a foot square, the pieces are united so as to render the concentric lines of the stone continuous, and thus, as may be seen in the Palazzo Pitti at Florence, massive slabs of six or seven feet in length are formed of apparently one piece of this beautiful substance. Some varieties are used as pigments.

#### MURIATE OF COPPER.

Prismatoidal Habroneme Malachite, *M.* Di-prismatic Habroneme Malachite, *Haid.* Prismatic Atacamite, *J.* Muriate of Copper, *P.* Rame Muriato, *Mont.* Salzkupfererz, *W.* Cuivre Muriaté, *H.*

Sp. Gr. 4.0—4.3. H. = 3.0—3.5.

Prismatic. FIG. 26. Inclination of P to P =  $107^{\circ} 10'$ , of M to M over  $h = 67^{\circ} 15'$ . Colour various shades of green. Translucent more or less. Lustre vitreous. Streak apple green. Cleavage perfect parallel to P. Consists of

Oxide of copper	76.6	73.0
Muriatic acid	10.6	10.1
Water	12.8—Proust.	16.9—Klaproth.

It dissolves without effervescence in nitric acid. When exposed to the blowpipe it tinges the flame bright green and blue colours, muriatic acid rises in vapours, and a bead of copper remains on the charcoal.

#### OBSERVATIONS.

The term *Atacamite* arises from the green sand, in which form this species is best known, being found in the river Lipas in the Atacama desert of Chili. It also occurs in the iron repositories of Schwartzenberg in Saxony, and on the lava of Vesuvius, where it is probably formed by the union of muriatic acid and carbonate of copper, both of which are well known to be deposited by sublimation at that volcano. Sometimes it is produced when metallic copper or copper ores are exposed to the action of sea water, or even of the atmosphere.



## STRAHLERZ.

Diatomous Habroneme Malachite, *M.* Axotomous Habroneme Malachite, *Haid.*  
 Radiated Acicular Olivenite, *J.* Oblique Prismatic Arseniate of Copper, *P.* Strahlerz,  
*Hoff.* Cuivre Arseniaté Ferrifère, *H.* Cuivre Arseniaté en Prisme Rhomboidal Ob-  
 lique, *Levy.*

Sp. Gr. 4.15—4.25. H. = 2.5—3.0.

Hemi-prismatic. FIG. 75. In mamillated or stellated groups of very minute crystals; inclination of  $M$  to  $M' = 124^\circ$ , of  $P$  to  $M' = 95^\circ$ , of  $P$  to  $c$  over the summit =  $99^\circ 30'$ . Colour dark verdigris-green inclining to blue, still darker on the surface. Translucent on the edges. Lustre pearly on the face  $P$ . Streak verdigris-green. Cleavage highly perfect, parallel to  $P$ . It consists of oxide of copper 54.0, arsenic acid 30.0, water 16.0—Chenevix. It deflagrates before the blowpipe, emits arsenical odours, and fuses with great facility.

## OBSERVATIONS.

This species is only known in Cornwall, where it accompanies others of the order malachite. The crystals present a very dark blue colour and brilliant lustre, but are rarely recognisable, being aggregated in diverging groups, or disposed in extremely minute individuals in the cavities of quartz.

## ERINITE.

Dystomic Habroneme Malachite, *Haid.*

Sp. Gr. 4.0—4.1. H. = 4.5—5.0.

In mamillated crystalline groups, consisting of concentric coats with rough surfaces, and presenting fibrous structure. Colour brilliant emerald-green, slightly inclining to grass-green. Streak likewise green, a little paler. Lustre none. Faintly translucent on the edges. Brittle. Fracture uneven or imperfect conchoidal. Contains oxide of copper 59.44, alumina 1.77, arsenic acid 33.78, water 5.01—Turner.

## OBSERVATIONS.

It occurs associated with arseniate of copper in the county Limerick, and was distinguished by Haidinger (*Brewster's Journal*, ix. 93). The appropriate name of Erinite was proposed by my father, as well in allusion to its locality as in reference to its characteristic emerald-green colour.

## BROCHANTITE.

*Levy, Ann. of Phil. 1824.*

$$H. = 3.5-4.0.$$

Prismatic. FIG. 52. Inclination of *o* to *o* contiguous =  $150^{\circ} 30'$ , of *M* to *M* over the terminal edge between *o* and *o* =  $114^{\circ} 20'$ , of *d* to *d* over *P* =  $117^{\circ} 0'$ . Colour emerald green. Transparent. Lustre vitreous. Traces of cleavage parallel to *M*. Surface of *M* dull and black, the remaining faces smooth and shining. According to Children, it consists of sulphuric acid, oxide of copper, and a little silica or alumina. It is soluble in muriatic acid, and before the blowpipe blackens without fusing.

## OBSERVATIONS.

This mineral was described by Levy in the Annals of Philosophy for 1824, and named by him in honour of Mons. Brochant. It is found in small but well-defined crystals with malachite and native copper, at Ekatherineburg in Siberia.

The *Konigine* of some mineralogists, from the same locality, is a variety of this species; and that from Resbanya in Hungary, analysed and described by Gustav Magnus of Berlin, appears also to be closely allied to Brochantite.

KUPFERSAMMTERZ. *Velvet blue**Cuivre Velouté, Levy.*

Consisting of short delicate fibres of a fine smalt blue colour, frequently grouped in spherical globules, which are produced by the divergement of the capillary crystals from a centre.

## OBSERVATIONS.

It occurs principally at Moldawa in the Bannat, coating the cavities of an earthy oxide of iron. From its extreme rarity, the characters of the species have not yet been accurately ascertained.



## ORDER MICA.

### COPPER MICA.

Rhombohedral Euclore Mica, *M.* Prismatic Copper Mica, *J.* Rhomboidal Arseniate of Copper, *P.* Foliated Arseniate of Copper, *Cleav.* Kupferglimmer, *W.* and *L.* Cuivre Arseniaté Lamelliforme, *H.*

Sp. Gr. 2·5—2·6. H. = 2·0.

Rhombohedral. FIG. 76. In hexagonal plates, bounded by six narrow trapezoidal faces, three of which, taken alternately, are inclined toward one of the broader faces, and the remaining three toward the other. These plates are often applied to each other laterally, forming rosettes, which are divisible like mica. Inclination of *P* to the alternate *P* = 68° 45'. *Colour* emerald or grass green. Transparent or translucent. *Lustre* pearly parallel to *o*, vitreous parallel to *P*. *Streak* rather paler than the colour. *Cleavage* highly perfect parallel to *o*, the surface of which is sometimes striated in triangular directions. Consists of

Oxide of copper	39·0	58·0
Arsenic acid	43·0	21·0
Water	17·0—Vauquelin.	21·0—Chenevix.

It decrepitates before the blowpipe, forms a black scoria, and then fuses into a black globule. With borax it affords a bead of copper.

#### OBSERVATIONS.

This mineral is as yet peculiar to the mining district of Cornwall, where it occurs in copper veins traversing killas, associated with several of the ores of malachite. The copper mines of Tingtang, Wheal Gorland, and Wheal Unity, near Redruth, are its principal localities.

### KUPFERSCHAUM.

Prismatic Euclore Mica, *M.* Cupriferos Calamine, *P.* Zinc Hydraté Cuprifère, *Levy.*

Sp. Gr. 3·0—3·2. H. = 1·0—1·5.

Prismatic. Occurs in rhombic plates, which are perfectly cleavable parallel to the face of the rhomb. *Colour* pale apple

green and verdigris green, inclining to sky blue. Translucent. *Lustre* pearly on the faces of the rhomb. *Streak* similar to the colour, but paler. Thin laminæ are flexible. According to Brooke, it consists of hydrate of zinc and copper; and before the blowpipe fuses on charcoal into a black globule.

## OBSERVATIONS.

In general we find this mineral forming small aggregated and diverging fibrous groups of a pale-green colour, and possessing a delicate silky lustre, disposed in the cavities of calamine, calc spar, or quartz. It occurs in the Bannat, at Libethen in Hungary, Nerzschinsk in Siberia, Schwatz in the Tyrol, Saalfeld in Thuringia, and Matlock in Derbyshire.

## URANITE.

Pyramidal Euclore Mica, *M.* Pyramidal Uranite, Pyramidal Uran Mica, *J.* Uranite, Phosphate of Uranium, *P.* Uranglimmer, *W.* Uranoxyd, *Haus.* Urane Oxydé, *H.*

Sp. Gr. 3.1. H. = 2.0—2.5.

Pyramidal. FIG. 77. Inclination of P to P =  $95^{\circ} 46'$ , of P to P' =  $143^{\circ} 2'$ . Colour emerald green, grass green, or siskin green, approaching to yellow. Transparent, translucent, or opake. *Lustre* pearly upon the face *o*, parallel to which the cleavage is highly perfect and easily obtained. Sectile. *Streak* corresponding to the colour, though paler, inclining from light green to yellow. Laminæ are brittle, but not flexible. Consists of,

	Cornwall.		Autun.
Oxide of uranium	60.0	60.25	59.37
Phosphoric acid	15.3	15.57	14.63
Oxide of copper	9.0	8.44	0.00
Silica	0.5	0.00	0.00
Water	13.8 Phillips.	15.05 Berz.	14.90 Berz.

The variety from Autun exhibited besides, traces of fluoric acid and ammonia; that from Cornwall, arsenic and fluoric acids. Before the blowpipe it becomes yellow and opake. On charcoal it intumesces, loses about one third by ignition, and fuses into a black globule with traces of crystallization upon the surface. With borax it forms a yellowish-green glass, and in nitric acid dissolves without effervescence, yielding, when pure, a lemon-yellow solution, if the acid be saturated.



## OBSERVATIONS.

Splendid crystals of this beautiful substance were formerly found at the mine of Gunnis Lake, latterly at Tincroft and Wheal Buller near Redruth in Cornwall. The siskin green, or almost yellow variety, occurs in granite veins at St Symphorien near Autun, and at St Yrieix near Limoges, in France. It is also met with in the Saxon mining districts of Schneeberg and Johanngeorgenstadt, near Baltimore in North America, and in other places. The thin tabular-shaped crystals in which the Uranite most frequently occurs, are composed of laminæ, applied to each other by their broader faces, and appear either as mere scales on the surface of other minerals, or in diverging plates assuming the arrangement so well known in the Prehnites of Dauphiné. Its natural colour appears to be siskin green or yellow, the hue of the green varieties being attributed to the presence of copper. This mineral sometimes might be confounded with green mica, but the laminæ of mica are flexible and elastic, while those of uranium are brittle and do not bend; mica, moreover, is not soluble in nitric acid.

The *Uran Ochre* of Werner appears to be the same substance in a friable state. It presents a brilliant orange-yellow colour, is extremely soft, and adheres to the finger; it is frequently met with, in minute flocculent masses, coating the uranium ore from Joachimsthal.

## COBALT BLOOM.

Prismatic Cobalt Mica, *M.* Diatomous Euclas Haloide, *Haid.* Prismatic Red Cobalt, *J.* Red Cobalt, Arseniate of Cobalt, *P.* Rother Erdkobold, *Wern.* Kobaltbluthe, *Haus.* Arseniksaures Kobalt, *L.* Cobalt Arseniaté, *H.*

Sp. Gr. 2.9—3.1. H. = 2.0—2.5.

Hemi-prismatic. FIG. 40. Right oblique-angled prism, the well-pronounced crystals however always very minute. *Colour* crimson and peach-blossom red, sometimes pearl grey or green. *Translucent*, the red tints very brilliant by strong transmitted light. *Lustre* pearly, on some faces inclining to vitreous. *Streak* corresponding to the colour, though a little paler. When crushed in a dry state the powder possesses a lavender-blue tinge, which is not the case if moistened. *Sectile.* *Cleavage* perfect in the direction of the prism. *Fracture* not observable. Contains oxide of cobalt 39.0, arsenic acid 37.0, water 22.0—Bucholz.

Alone before the blowpipe it assumes a darker colour, emits copious arsenical fumes, and melts in the reducing flame into a bead of arseniuret of cobalt. With borax and other fluxes it yields a fine blue-coloured glass.

## OBSERVATIONS.

This beautiful mineral occurs either in micaceous scales radiating from a centre, in minute aggregated crystals, or coating other minerals in the

state of a peach-blossom-red powder. Schneeberg in Saxony is the principal locality of the first of these varieties; brilliant specimens of the second are met with at Saalfeld in Thuringia, and at Riegelsdorf in Hesse; while the earthy red cobalt occurs in Dauphiné, in Cornwall, at the lead mine of Tyne Bottom near Alston in Cumberland, and in many other places. A perfectly green variety occurs at Platten in Bohemia, and sometimes red and green tinges appear on the same crystals. When in sufficient quantity, it is used in making smalt, and affords a good blue colour. It bears some resemblance to red antimony and capillary red copper ore, but may be distinguished from both these minerals by the blue glass it yields with borax, and by its crystals not occurring in such lengthened individuals; the first of these, too, presents a more sombre, the latter a more brilliant red, than cobalt bloom.

### VIVIANITE.

Prismatic Iron Mica, *M.* Dichromatic Euclas Haloide, *Haid.* Prismatic Blue Iron, *J.* Phosphate of Iron, Vivianite, *P.* Blauc-Eisenerde, *Wern.* Eisenblau, *Haus.* Phosphorsaures Eisen, *L.* Fer-phosphaté, *H.*

Sp. Gr. 2.66. H. = 2.0.

Hemi-prismatic. FIG. 37. Analogous in form to gypsum. Colour varying from pale green to indigo blue, according as it is viewed in the direction of the faces *l* and *f*. Transparent, or translucent, with a partly metallic, partly vitreous lustre. Streak almost white, but on exposure to the air soon changes into indigo-blue. The powder produced by crushing the mineral in a dry state is liver brown. Sectile in thin laminæ. Cleavage highly perfect parallel to P. Fracture not observable.

Two varieties, a friable one analyzed by Klaproth, the other crystallized from Bodenmais in Bavaria, yielded the following results:—

Protoxide of iron	47.5	41.0
Phosphoric acid	32.0	26.4
Water	20.0 Klaproth	31.0 Vogel,

its chemical formula, according to Berzelius, being 43.88 protoxide of iron, 22.28 phosphoric acid, and 33.84 water. It decrepitates before the blowpipe, but fuses, if previously reduced to powder, into a dark-coloured scoria which affects the magnetic needle. It is soluble without effervescence in dilute sulphuric and nitric acids. The friable varieties are found white in their original repositories, but, like the streak of the crystals, they soon assume a blue tinge on exposure.



## OBSERVATIONS.

The name Vivianite is generally applied to the large transparent crystallized varieties of this species, particularly to those from Cornwall, and Bodenmais in Bavaria; the compact and earthy being more commonly known under the denomination of blue iron. Near St Agnes in Cornwall transparent indigo-coloured crystals have been found an inch in diameter and two in length, disposed on magnetic pyrites. Those from Bodenmais are accompanied with iron- or magnetic-pyrites, in gneiss, their crystalline form resembling the common variety of gypsum from Shotover. On the promontory of Kertz in the Black Sea, it has been found in large indistinct crystals occupying the interior of shells. At the gold mines of Vöröspatak in Transylvania, where it was first discovered, it was taken for blue gypsum. The *Earthy Blue Iron* is found in compact masses in New Jersey, also in Greenland, Stiria, Carinthia, Cornwall, and other places. The friable varieties are imbedded in clay, and have been discovered deposited in bog iron-ore in several peat mosses in the Shetland Isles; at Ballagh in the Isle of Man accompanied with animal matter, particularly the horns of the elk and deer; in large quantities in a bog near Ormskirk, forming a blue crust on the peats when dry, &c. This variety was also lately met with in soft friable clay, near an old slaughter-house which was removed for the foundation of the West Bridge, at the foot of the Castle Rock, Edinburgh, indicating very distinctly a formation of no very remote date. It is sometimes used as a pigment.

## CRONSTEDTITE.

Rhombohedral Melane Mica, *M.* Cronstedtit, *L.* Sideroschisolite, *Wernekingk*, Poggendorf Ann. 1824.

Sp. Gr. 3.3. H. = 2.5.

Rhombohedral. FIG. 78. A hemi-rhombohedral combination with inclined faces, sometimes also in six-sided prisms tapering towards their summit, or adhering laterally. *Colour* brownish-black, with a brilliant vitreous lustre. *Streak* dark leek-green. *Opake*, and somewhat elastic when in thin laminæ. *Cleavage* perfect parallel to *o*. Contains,

	<i>Cronstedtite.</i>	<i>Sideroschisolite.</i>
Silica	22.45	16.3
Oxide of iron	58.85	75.5
Oxide of manganese	2.89	0.0
Alumina	0.00	4.1
Magnesia	5.08	0.0
Water	10.70 Steinmann.	7.3 Wernekingk.

Before the blowpipe it froths a little, but does not melt, and with borax affords a hard black opaque bead. When reduced to powder it gelatinizes in concentrated muriatic acid.

## OBSERVATIONS.

It occurs at Przibram in Bohemia, in veins containing silver ores, accompanied with hydrate of iron and calc spar; in diverging groups also at Wheal Maudlin in Cornwall; and associated with quartz and magnetic pyrites at the mines of Conhonas do Campo in Brazil.

## CHLORITE.

Prismatic Talc Mica, *M.* Rhomboidal Mica (in part), *J.* Talc, Green-Earth, Chlorite, *P.* Topfstein, Grunerde, Chlorit, Talk, and Talk-glimmer of the Germans. Talc (in part), *H.*

Sp. Gr. 2.7—2.8. H. = 1.0—1.5.

**Prismatic.** In rhomboidal plates with angles of  $120^\circ$  and  $60^\circ$ , also in rectangular four-sided and hexagonal plates. *Colour* various shades of green, passing from dark-green into apple-green and greenish-grey; also pure white and yellowish. *Semi-transparent*, translucent, presenting different colours in different directions. *Lustre* pearly on the terminal planes, parallel to which the cleavage is highly perfect. Yields to the nail, and when in powder, is unctuous to the touch. *Streak* corresponding to the colour, generally white or green. Thin laminæ are easily flexible, but not elastic; a character which serves to distinguish this mineral from mica, which is very elastic. Three varieties of this species, the foliated talc, slaty chlorite, and green earth, have yielded the following results:

Silica	62.0	29.5	52.0
Magnesia	27.0	21.4	6.0
Oxide of iron	3.5	23.4	23.0
Alumina	1.5	15.6	7.0
Water	6.0	7.4	4.0
Potash	0.0	0.0	7.5
Lime	0.0 Vauq.	1.5 Gruner.	0.0 Vauq.

presenting considerable discrepancy in their chemical composition. Before the blowpipe some varieties lose their colour, and are difficultly fusible, others (the green-earth in particular) are changed into a black scoria, and, probably from their deficiency in potash and magnesia, will not fuse at all.



## OBSERVATIONS.

This species includes all the varieties classed by mineralogists under the three heads of Chlorite, Green Earth, and Talc. *Chlorite*, as its name from the Greek signifies, comprehends such as are flexible and of a dark-green or brown colour; *Foliated Chlorite* contains the crystallized varieties, and such compound ones as consist of easily separable individuals; *Chlorite Slate* possesses a glistening lustre, and slaty structure; while *Earthy Chlorite* applies only to such varieties as are slightly coherent, or already in the state of loose scaly particles. Closely connected with this is *Green Earth*, the *Talc-Zographique* of Hauy, which occurs in bluish or dark-green masses, imbedded in, or coating the cavities of amygdaloid, and not unfrequently associated with some species of the zeolite family. *Talc* again comprehends the lighter coloured varieties, and is divided into *common*, *earthy*, and *indurated*. The first of these has generally either a slaty structure or columnar composition. The *Earthy Talc*, or *Nacrite* as it is called, consists of loose particles, or such as are but slightly cohering, a variety of frequent occurrence in the silver veins of Freyberg; while the *indurated Talc* refers to those imperfect and coarse slaty varieties in which this structure is more the consequence of composition than of imperfect cleavage. When very coarse, and indistinctly granular, *Pot-stone* or *Lapis Ollaris* is formed, which, possessing the united properties of softness and tenacity, may be easily turned into cooking utensils and other vessels.

One of the most beautiful dark-green foliated chlorites occurs in the Taberg iron mines of Wermeland in Sweden; the grey variety is found in Aberdeenshire. In Cornwall, where it is known under the title of *Peach*, some of the more crystalline kinds are met with in metallic veins. Apple-green coloured talc, in large foliated masses, occurs in the island of Unst, one of the Shetlands; also in the Greiner mountain in Salzburg, and in the Vallais. The same, disposed in stellular concretions, imbedded in quartz, is found in Sweden; and a beautiful massive and translucent white variety at Almorah, in the Himalayah mountains. Snow-white friable nacrite, in minute laminæ, which adhere to the finger, occurs at St Gothard, and Monte Baldo near Verona. The Faroe Islands, Iceland, and the Tyrol, are the principal localities of green-earth; while the pot-stone is very common in the Valais and Grisons, where it is turned into vessels, and used as fire-bricks in the construction of stoves. At Wald in Styria it forms extensive beds, and is there sawn into blocks for building the iron furnaces at Vordernberg. Green-earth is employed, both raw as a green colour, and when burnt as a reddish-brown tint, for painting houses, &c.

Its character of being unctuous to the touch when reduced to powder, as also its want of flexibility, distinguishes this species from any of the following. It likewise acquires resinous electricity when rubbed; whereas mica under similar circumstances becomes vitreous.

## MICA.

Rhombohedral Talc Mica, *M.* Rhomboidal Talc Mica, *J.* Mica, *P.* Glimmer *of the Germans.* Mica, *H.*

Sp. Gr. 2·8—3·0. H. = 2·0—2·5.

Rhombohedral. FIG. 22. In regular six-sided prisms, easily cleavable perpendicular to their axis. *Colour* generally dark-green or brown. Varying between transparent and opaque. *Lustre* pearly, often inclining to metallic on the terminal faces of the prism. *Streak* white or grey. Sectile. Thin laminae are flexible and very elastic. Contains

	Black from Siberia.	Siberia.
Silica	42·5	42·50
Alumina	11·5	16·05
Magnesia	9·0	25·97
Potash	10·0	7·55
Oxide of mangan.	2·0	0·00
Oxide of iron	22·0—Klaproth.	4·93—Rose.

Before the blowpipe it sometimes fuses into a scoria, but generally only becomes white and opaque.

## OBSERVATIONS.

Polarized light is peculiarly applicable to the examination of the different varieties of mica, and affords an excellent means of distinguishing with great facility the present from the following species. These were always looked upon as one, until the numerous investigations of Brewster, Biot, Seebeck, and Soret, pointed out to mineralogists the necessity of separating the varieties of mica which possess only one axis of double refraction, and therefore belong to the rhombohedral system, from those which present a double system of rings, and on that account are included in the hemi-prismatic.

The varieties of the present species differ also materially from those of the following in their composition. They generally contain several per cent. of magnesia, and afford no indications of the presence either of fluoric acid, boracic acid, or lithia, which many of the following do. The most remarkable varieties of this species are the dark-coloured micas from Siberia; and the deep brown and most perfectly formed six-sided prisms, often as transparent and brilliant as any gem, which are met with in the cavities of the ejected masses from Vesuvius. The abundance of this species in nature, however, bears no proportion to the universal diffusion of the following.



## TALC-MICA.

Hemi-Prismatic Talc-Mica, *M.* Rhomboidal Talc-Mica, *J.* Lepidolite, *P.* Glimmer of the Germans. Mica, *H.*

Sp. Gr. 2·8—3·0. H. = 2·0—2·5.

Oblique rhombic prisms of about 120°. *Colour* white, grey, pale-green, and yellow. *Transparent* and translucent. *Lustre* pearly. *Streak* white or grey. *Sectile*. *Flexible*, and elastic when in laminæ, by which character this and the preceding species may be distinguished from chlorite. The chemical composition varies considerably, particularly as to the amount of iron, which in a variety from Cornwall has been found as much as 27·06 per cent.

	Zinnwald.	Kimito.	Lepidolite.
Silica	47·00	46·23	46·36
Alumina	20·00	14·14	36·80
Potash	14·50	4·90	9·22
Oxide of iron	15·50	17·97	4·53
Oxide of manganese	1·75	4·57	0·00
Fluoric acid and water	0·00	3·73	1·81
Lithion	0·00	4·21	0·00
	Klaproth.	Gmelin.	Rose.
			Turner.

Before the blowpipe the talc-mica generally does not fuse, but only loses its transparency and becomes white; those varieties, however, which contain lithia, melt readily on exposure to it, and at the moment of fusion tinge the flame of a delicate red hue. Those of a dark colour, which contain most iron, frequently act upon the magnet, and always present, when examined by means of polarized light, the two systems of coloured rings peculiar to those species which possess two axes of double refraction.

## OBSERVATIONS.

Talc-mica is an essential constituent of some of the primary rocks, as granite, gneiss, and mica slate. It frequently forms nodules and concretions in these rocks, and is associated with tin, topaz, tourmaline, and other minerals. It also occurs in sandstone, and in schists.

A cleavable variety in particularly large individuals, sometimes exceeding a yard in diameter, is found in Siberia imbedded in granite; this, when reduced to considerable tenuity, is transparent, and from the circumstance of its being used in that country for glazing windows,

has received the appellation of *Muscovy-glass*; although, from its becoming white and opaque on exposure to the air, it affords but a poor substitute for window glass. The same material is used on board the Russian ships of war, as less liable to fracture during the discharge of heavy artillery. Being, according to Haüy, divisible into plates no thicker than  $\frac{1}{250,000}$ th part of an inch, it is separated into the most delicate films for various optical purposes. The large plates from Siberia are not always devoid of colour, but, on the contrary, present deep orange-red and dark olive-green hues. Many fine specimens occur in America, also in Aberdeenshire and other counties of Scotland. St Gothard in Switzerland, Pargas in Finland, Arendal in Norway, Finbo and Broddbo in Sweden, Zinnwald in Saxony, and Hörlberg in Bavaria, are among its best-known localities; but the rocks in which it occurs are so universally distributed, that it would be endless to enter into further detail of localities.

With talc-mica is included the granular variety, of a peach-blossom red colour, called *Lepidolite*, the specific gravity of which is generally lower than that of other micas. It however presents all the optical and chemical properties peculiar to this species, with which it appears to be very properly classed. It is found principally near Rosena in Moravia, and associated with petalite at Utön in Sweden.

In several species of mica Rose found fluoric acid, particularly the mica of granites. Those which contain about one per cent. of this acid lose their lustre on exposure to fire; while such as present only a trace, assume a semi-metallic lustre. Others again, as has been noticed by Gmelin, contain a considerable portion of boracic acid, the *Lepidolite* particularly, in which it amounts to about four per cent.; and in some, the presence of Lithia may with facility be ascertained by exposing a lamina to the flame of the blowpipe. (Turner on Lithion Mica, Brewster's Jour. III, 261.) The different varieties of mica are characterized by the peculiar facility with which they separate into thin elastic laminæ.

### MARGARITE.

Rhombohedral Pearl Mica, *M.* Rhomboidal Pearl Mica, *J.* Perlglimmer, *L.*

Sp. Gr. 3.0—3.1. H. = 3.5—4.5.

Rhombohedral. In thin crystalline laminæ intersecting each other in every direction. *Colour* pale pearl-grey, passing into reddish and yellowish-white. Translucent. *Lustre* pearly upon the terminal faces, vitreous on the others. *Streak* colourless. *Cleavage* highly perfect, parallel to the base of a six-sided prism. Rather brittle. Contains silica 37.00, alumina 40.50, oxide of iron 4.50, lime 8.96, soda 1.24, water 1.00, making a loss of 6.80—Du Ménil.



## OBSERVATIONS.

The pearl mica occurs in primitive rocks, mixed with and engaged in foliated chlorite, at Sterzing in the Tyrol. It is distinguished from the preceding species by its superior hardness and specific gravity.

## HYDRATE OF MAGNESIA.

Native Magnesia, *J.* Native Hydrate of Magnesia, *Brewster*. Magnesia-Hydrat, *Haid*.  
Native Magnesia, *Cleav.* Magnesie Hydratée, *H. Hibbert* in Trans. Edin. Roy. Soc. IX. 259.

Sp. Gr. 2.35. H. = 1.0—1.5.

Rhombohedral. In large foliated plates, rarely presenting indications of flat six-sided prisms. *Colour* white, tinged occasionally green. Translucent, becoming opaque on exposure to the air. *Lustre* pearly. *Streak* white. Thin laminae slightly flexible. *Cleavage* highly perfect parallel to the face of the prism. Yields to the nail, and adheres slightly to the tongue.

Contains

	Hoboken.		Unst.
Magnesia	70.0	69.75	66.67
Water	30.0	Bruce. 30.25	Fyfe. 30.39 Stromeyer.

Stromeyer also remarked a little oxide of manganese, iron, and lime. Before the blowpipe it loses its transparency and weight, and becomes friable. In acids it is entirely dissolved without effervescence.

## OBSERVATIONS.

The hydrate of magnesia was discovered, and ranked as a distinct species, by the late Dr Bruce of New York. It occurs in considerable veins traversing serpentine at Swinanness in Unst, one of the Shetland Isles; as also at Hoboken in New Jersey, under similar circumstances. It bears some resemblance to talc, but the latter possesses a higher specific gravity, and is not so hard; it also marks paper with a silvery powder, while the talc leaves a polished line; the hydrate of magnesia too is soluble in acids, which the other is not, and acquires the vitreous electricity when rubbed, while talc under similar circumstances exhibits the resinous.

## PYROSMALITE.

Pyrosmalite, *J.* and *P.* Pyrodmalith, *L.* Fer Muriaté, *H.*

Sp. Gr. 3.0—3.1. H. = 4.0—4.5.

In regular six-sided prisms, of a pale liver-brown colour, passing into grey and pistachio-green. Translucent or opaque.

*Lustre* pearly upon the terminal faces of the prism, less so in other directions. *Cleavage* perfect perpendicular to the axis, less so parallel to it. *Fracture* uneven. *Streak* paler than the colour. Rather brittle. Consists of,

Silica	35.85
Protoxide of iron	21.81
Protoxide of manganese	21.14
Muriate of iron	14.10
Lime	1.21
Water	5.89 Hisinger.

Before the blowpipe it becomes reddish-brown, and gives off fumes of muriatic acid; in a strong fire it forms first a black scoria, and then a globule which attracts the magnet. It fuses easily with glass of borax, presenting the colours characteristic of iron, and is soluble in muriatic acid, leaving a small residuum of silica.

#### OBSERVATIONS.

The only known locality of this mineral is Bjelkegruvan, one of the iron mines of Nordmark in Wermeland, Sweden, where it occurs associated with calc spar, augite, apophyllite, and magnetic iron ore. In the museum at Stockholm there is a particularly fine detached crystal of pyrosmalite, presenting a perfect six-sided prism about an inch and quarter long, nearly an inch in diameter, and which weighs five and a half ounces; and in the cabinet of Mr Heyer of Dresden is another, though of smaller dimensions, having the alternate terminal edges of the prism replaced. It has been found, at the above-mentioned place, both crystallized and massive, though in neither form is it of frequent occurrence.



## ORDER STEATITE.

### SOAP STONE.

Steatite or Soapstone, *J. and P.* Speckstein, *W.*

Sp. Gr. 2·6—2·65. Soft or very soft.

*Colour* generally white, passing into grey, green, red, and yellow. Translucent on the edges. *Streak* having a faint resinous lustre. Yields to the nail, and possesses an unctuous feel. Does not adhere to the tongue. Has an uneven fracture, and is perfectly sectile. Consists of

	Bayreuth.	Cornwall.
Silica	59·5	40·5
Magnesia	30·5	24·7
Alumina	0·0	9·3
Oxide of iron	2·5	1·0
Water	5·5—Klaproth.	18·0—Klaproth.

Before the blowpipe it is very difficultly fusible, and only partly vitrified.

#### OBSERVATIONS.

At Göpfersgrün, in the principality of Bayreuth, there occur, imbedded in a massive variety of the same mineral, distinctly pronounced pseudo-crystals of steatite, assuming precisely the same form as the common variety of quartz; and, though less frequently, those also of calcareous and pearl spar. Indeed Haüy not only remarks the identity in the measurement of their angles, but observes that they are frequently streaked like quartz, transversely on the faces of the prism. The soapstone found in a vein of serpentine, at the Lizard Point, Cornwall, may, when first extracted, be kneaded like dough, but on exposure loses part of its moisture, and becomes translucent on the edges; sometimes also it has a speckled appearance. A compact and massive sky-blue coloured steatite occurs mixed with limestone, and containing fragments of encrinite, at Bogie Quarry near Kirkaldy, in Fifeshire. From St Helena and China it has been brought of the most perfect cream colour; and it is common in many other parts of the world. The white

varieties, or those that become so by calcination, are used in the manufacture of fine porcelain; others are sometimes employed in fulling; while, as it marks cloth and leaves traces on glass, it is occasionally made into pencils for tailors' and glaziers' purposes. Humboldt assures us that the Otomacks, a savage race on the banks of the Orinoco, live for nearly three months of the year principally by eating a kind of steatite, which they first slightly bake, and then moisten with water. It is used for polishing mirrors, for giving lustre to marble, in the formation of glazed paper, and as a basis of some preparations of paint. It facilitates the action of screws; and from its unctuousity or greasy feel (a property arising from the large portion of magnesia it contains), is employed advantageously in diminishing the friction of machinery; for this purpose it is pulverized, and mixed with oil, tallow, or tar, and when freed from grit may be used even for carriage wheels. (Brewster's Jour. ix. 166.)

#### AGALMATOLITE.

Figure Stone or Agalmatolite, *J. and P.* Bildstein, *W. and L.* Talc Graphique, *H.*

Sp. Gr. 2·8—2·85. Soft.

Occurs massive, sometimes with an imperfectly slaty structure. *Colour* generally yellow, grey, or brown; rarely also pink, and mottled. Translucent on the edges. Acquires some lustre in the streak. Feels greasy, and yields to the nail. Perfectly sectile. Consists of

Silica	56·0	54·50	49·82
Alumina	29·0	34·00	20·59
Lime	2·0	6·25	6·00
Potash	7·0	0·00	6·80
Oxide of iron	1·0	0·75	1·50
Water	5·0—Vauq.	4·00—Klap.	5·00—Thom.

Before the blowpipe it whitens, but is infusible; and with borax affords a colourless glass. It is partly soluble in sulphuric acid, leaving a siliceous residue.

#### OBSERVATIONS.

It occurs principally in China, whence it is brought in the form of grotesque figures, and chimney-piece ornaments. Less characteristic varieties occur in Transylvania, Norway, and Wales. It strongly resembles the foregoing species in most of its physical characters, but differs essentially in composition; the large proportion of alumina which it contains, and its total want of magnesia, serving sufficiently to distinguish it.



## SERPENTINE.

Edler Serpentin, *W.* Ophite, *L.*

Sp. Gr. 2.5—2.6. H. = 3.0.

Prismatic. FIG. 79. Inclination of *o* to *o* over the terminal edge =  $128^{\circ} 31'$ , of *d* to *d* over *b* =  $97^{\circ} 33'$ , and of *d* to *d* over *s* =  $82^{\circ} 27'$ . Colour commonly dark green, passing into yellow and grey. Translucent or opaque. Lustre resinous, but having low degrees of intensity. Streak white, with some lustre. Fracture conchoidal or splintery. Consists of

	<i>Ophite.</i>	<i>Noble Serpentine,</i> <i>Fahlun.</i>
Silica	42.50	41.95
Magnesia	38.63	40.64
Alumina	1.00	0.37
Lime	0.25	0.00
Oxide of iron	1.50	2.12
Oxide of manganese	0.62	0.00
Oxide of chrome	0.25	0.00
Water	15.20	11.68

Carb. acid and bitumen 0.00 John. 3.42 Lychnell.

It loses its water and hardens on exposure to heat, but fuses before the blowpipe with great difficulty, and only on the edges. With borax it melts slowly into a greenish transparent glass. It neither adheres to the tongue, nor is scratched by the nail.

## OBSERVATIONS.

Dark green opaque crystals of this substance have been met with in the Fassa valley, Tyrol; their form, however, is generally so indistinct that only a few of the faces marked upon the above figure can be traced in any one individual; and on that account they have been by some mineralogists, though incorrectly, considered pseudomorphous. At Snarum in Norway it is found in masses of a greenish-grey colour, which contain large and very perfect pseudomorphic crystals, but of a mineral as yet unascertained. The term *Noble* applies to those serpentines which have a uniform green colour, and are translucent and fit for cutting; of these the finest come from Fahlun and Gulsjo in Sweden, the Isle of Man, the neighbourhood of Portsoy in Aberdeenshire, Corsica, Silesia, Saxony, and Connecticut in North America. *Common* serpentine has a more earthy texture, is less impalpable, and often contains admixtures of foreign matter, such as grains of iron ore, which tend to raise its specific gravity

considerably above 2·6. It is frequently traversed by veins of asbestos, and occurs in masses and beds in primitive rocks, in the Shetland Isles, at the Lizard in Cornwall, in Piedmont, Saltzburg, and elsewhere on the continent. Serpentine is easily cut, the fineness and closeness of its grain rendering it susceptible of a high polish. It admits, from its toughness, of being turned on the lathe, and is formed into various ornaments, vases, boxes, and plates. At Zöblitz in Saxony, Bayreuth, and in Franconia, several hundred persons are employed in this manufacture; though the serpentine from these localities is much inferior in beauty and variety of colour to that from Portsoy. Chromate of iron always occurs associated with serpentine; and the many foreign substances with which it is united, as well as the different state of oxidation of the iron it contains, give it frequently a spotted or variegated appearance, similar in some respects to the skin of a snake; hence its Greek and Latin names of *Serpentine* and *Ophite*.

## GIESECKITE.

Sp. Gr. 2·8—2·85. H. = 2·5—3·0.

Rhombohedral. FIG. 22. In regular six-sided prisms, of an olive green, grey, or brown colour. Opake. *Lustre* resinous, though faint. *Streak* uncoloured. *Fracture* uneven, and cleavage imperceptible. Consists, according to Stromeyer, of silica 46·07, alumina 33·82, magnesia 1·20, oxide of iron 3·35, oxide of manganese 1·15, potash 6·20, water 4·88.

## OBSERVATIONS.

This mineral was brought by the late Sir Charles Giesecke from Akulliarasiarsuk, in the district of Julianshope, in Greenland. It occurs imbedded in compact felspar or quartz, and when decomposed, as it frequently is, presents a lighter colour. It possesses no regular structure, and does not appear homogeneous, but is interspersed with reddish-brown spots, which give it rather the appearance of a pseudomorphous steatitic mineral than a crystalline substance. Some mineralogists have united it with pinite, which it resembles in many respects. Dr Traill found it exceedingly refractory before the blowpipe, but when urged with the bellows it partially fused, and became magnetic; the colour it gave the flame indicated the presence of an alkali, and it contained a small portion of magnesia, but not a trace of lime. It slightly effervesces with nitric acid.



## FAHLUNITE.

Tricklasite, P. and H.

Sp. Gr. 2·6—2·7. H. = 3·0.

In six-sided prisms. *Colour* green, passing into dark brown and black. *Opake*. *Lustre* resinous or vitreous. *Streak* greyish-white. *Cleavage* perpendicular to the axis. Consists of

Silica	46·79	44·60
Alumina	26·73	30·10
Magnesia	2·97	6·75
Protoxide of iron	5·01	3·86
Oxide of manganese	0·43	2·24
Water	13·50 Hisinger.	9·35 Wachtmeister.

Before the blowpipe becomes grey, and melts on its thinnest edges ; but is slowly soluble with borax, yielding a glass slightly coloured by iron.

## OBSERVATIONS.

The only known locality of this mineral is the mine of Eric Matts, near Fahlun, in Sweden, where it occurs both massive and crystallized, imbedded in chlorite slate, and associated with dicroite. The crystals, however, from their highly perfect cleavage, almost invariably break in parallel position with the slate, and thus present only sections of their form.

## PINITE.

Pinit, W. Micarelle, Kirwan.

Sp. Gr. 2·78—2·8. H. = 2·0—2·5.

Rhombohedral. In four-sided prisms, having their lateral edges replaced by two planes ; thus generally assuming the form of twelve-sided prisms. *Colour* greenish-grey or brown. *Opake*, and almost devoid of lustre. *Streak* white. *Cleavage* indistinct, and *fracture* uneven. Consists of

	Auvergne.	Saxony.
Silica	55·96	29·50
Alumina	25·48	63·75
Potash	7·89	0·00
Oxide of iron	5·51	6·75
Magnesia	3·76	0·00
Water	1·41—Gmelin.	0·00—Klaproth.

with traces of lime, soda, and manganese.

Before the blowpipe it whitens and fuses on the edges, but does not melt. With borax it yields, after a continued blast, a transparent globule coloured by iron.

## OBSERVATIONS.

Werner distinguished this species, and named it from the Pini gallery in the Schneeberg mines, where it was first discovered. It occurs imbedded in decomposed felspar-porphry at the Puy de Dome in Auvergne; in granite at Schneeberg in Saxony, at Linsenz in the Tyrol, and elsewhere on the continent; also in Cornwall and Aberdeenshire in primitive rocks. The composition of the Saxon variety indicates a very different mineral from that of the other localities, neither has the blowpipe the slightest effect on it; no distinction, however, has been noticed in their forms.

## KILLINITE.

Sp. Gr. 2.65—2.75. H. = 4.0.

In irregular imbedded thin crystals, apparently rectangular four-sided prisms; or crystalline masses. *Colour* greenish-grey, often tinged brown by oxide of iron, or from decomposition. Faintly translucent. *Lustre* vitreous, but not strong. *Streak* yellowish-white. *Fracture* uneven. Consists of

Silica	52.49	49.08
Alumina	24.50	30.60
Potash	5.00	6.72
Oxide of iron	2.49	2.27
Oxide of manganese	0.75	0.00
Water	5.00—Barker.	10.00—Thomson.

It becomes white before the blowpipe, intumesces, and fuses with little difficulty into a white enamel.

## OBSERVATIONS.

The Killinite was discovered by Dr Taylor, who named it from its locality, Killiney Bay near Dublin, where it occurs in granite veins near their junction with mica slate. It is accompanied by spodumene, quartz, felspar, and garnet; and in external character strongly resembles the first of these minerals.

## PICROLITE.

Pikrolith, L.

H. = 3.5—4.0.

Massive, or fibrous with a radiated structure. *Colour* leek-



green passing into yellow. *Streak* a little shining. Translucent on the edges, or opaque. Consists of

Silica	40·04	40·98
Magnesia	38·80	33·44
Water	9·08	12·86
Protoxide of iron	8·28	8·72
Carbonic acid	4·70—Almroth.	1·73—Lychnell.

It colours glass of borax green, but the colour disappears on cooling.

## OBSERVATIONS.

This mineral occurs in irregular veins at the Taberg of Smoland in Sweden, traversing beds of magnetic iron ore, and associated with calc spar and serpentine; it is said also to be brought from Reichenstein in Silesia. It was named and described by Hausmann.

## PICROSMINE.

Sp. Gr. 2·58—2·66. H. = 2·5—3·0.

Prismatic. FIG. 80. Inclination of *i* to *i* contiguous = 117° 49', of *s* to *s* over T = 126° 52'. Massive. Colour generally greenish-white, sometimes dark green. Translucent on the edges, or opaque. Lustre pearly on the principal face of cleavage, parallel to M; inclining to vitreous on the others. Streak white and dull. Very sectile. According to the analysis of Magnus (Brewster's Journ. iv. 108), it consists of silica 54·88, magnesia 33·35, alumina 0·79, peroxide of iron 1·39, protoxide of manganese 0·42, water 7·30.

Before the blowpipe it does not melt, but gives out water, becomes first black, then white and opaque, and acquires a hardness equal to 5·0. It is soluble in salt of phosphorus, with the exception of a skeleton of silica; and when heated with solution of cobalt, it assumes a pale red colour.

## OBSERVATIONS.

The only known locality of Picrosmine is the iron mine of Engelsburg near Presnitz, in Bohemia, where it is associated with magnetic iron ore. In external appearance it resembles asbestos, but was distinguished from that mineral by Haidinger, who named it Picrosmine, from *πικρὸς* bitter, and *ὀσμή* smell, in allusion to the bitter and argillaceous odour which it exhales when moistened.

## PYRALLOLITE.

*Julin.* Ann. of Philosophy, I. 235. *Nordenskiöld.* Schweiggers, Jour. Neue Reihe, I. 386.

Sp. Gr. 2.55—2.6. H. = 3.5—4.0.

Tetarto-prismatic. FIG. 81. Inclination of *l* to M =  $140^{\circ} 49'$ , of M to T =  $94^{\circ} 36'$ , of *r* to T =  $130^{\circ} 33'$ , of M to *r* =  $144^{\circ} 3'$ . Usually massive, with a granular composition. Colour white and greenish. Translucent on the edges, or opaque. Lustre resinous. Fracture earthy, and cleavage parallel to the faces M and T.

According to Nordenskiöld, who discovered and described, as well as analysed this mineral, it consists of

Silica	56.62
Magnesia	23.38
Alumina	3.38
Lime	5.58
Oxide of iron	0.99
Protoxide of manganese	0.99
Water	3.58

leaving 6.38 of an unknown bituminous substance, and loss. Before the blowpipe it intumesces and melts on the edges; it has the singular property of blackening at a low red heat, and of afterwards becoming white at a higher temperature. With borax it yields a transparent glass; and when reduced to powder phosphoresces with a bluish light.

## OBSERVATIONS.

It occurs at Storgard in the parish of Pargas in Finland, accompanying hornblende, apatite, and felspar, and derives its name from the Greek *πυρ*, *αλλος*, *λιθος*, in allusion to the change of colour it presents when exposed to the action of fire.



## ORDER SPAR.

### DIALLAGE.

Diatomous Schiller Spar, *M.* Common Schiller Spar, *J.* Schillerstein, *W.* Talk-artiger Diallag, *Haus.* Schillerspath, *L.* Spath-Chatoyant, Diallage Métalloïde (in part), *H.*

Sp. Gr. 2·6—2·8. H. = 3·5—4·0.

Tetarto-prismatic. *Colour* dark olive-green, inclining to pinchbeck-brown, with a metallic lustre upon the faces of cleavage. Opake or translucent on the edges. *Streak* greyish-white. *Cleavage* in two directions, one highly perfect and easily obtained, the other appearing only in traces. Contains

Silica	41·00	43·90
Magnesia	29·00	25·85
Alumina	3·00	0·00
Lime	1·00	2·64
Oxide of iron	14·00	13·21
Water	10·00—Drapier. 12·43—Kohler.	

Becomes hard on exposure to a high temperature, and fuses with some difficulty into a porcelain-like mass.

#### OBSERVATIONS.

Diallage is a name proposed by Haüy, and by him applied not only to the Schillerstein of the Germans, but to several varieties of the Hornblende family which he brought into one species under this denomination. These now occupy their respective situations; and that variety alone, from Baste in the Forest of Harzburg in the Hartz, where it occurs mixed with massive serpentine in greenstone, has been ascertained to belong to the present species.—See *Haidinger on the Natural Historical Determination of Diallage*, Edin. Royal Society Trans. x. 127.

## BRONZITE.

Hemi-Prismatic Schiller Spar, *M.* Schiller Spar (in part), *P.* Blattriger Anthophyllite, *W.* Bronzit, *L.* Diallage Fibro-Laminaire Métalloïde, *H.*

Sp. Gr. 3·3—3·4. H. = 4·0—5·0.

FIG. 82. Inclination of *o* to *M* = 108°, of *s* to *s* over *M* = 86°. Colour several shades of dark-green, liver and pinchbeck-brown, and ash-grey. Lustre metallic-pearly, frequently resembling bronze. Thin laminæ translucent. Streak greyish, corresponding to the colour. Sectile. Cleavage highly perfect in one direction. Easily frangible. The Styrian variety consists of

Silica	60·0
Magnesia	27·5
Oxide of iron	10·5
Water	0·5—Klaproth.

It assumes a lighter colour on exposure to heat, and loses its water, but alone is infusible.

## OBSERVATIONS.

Bronzite rarely occurs crystallized, but is found imbedded in serpentine and greenstone rocks, in crystalline masses, which cleave with great facility into thin laminæ. A beautiful pearl-grey coloured variety, presenting extremely large individuals, occurs on the Monte Bracco, near Sestri, on the coast road from Genoa to Nice; indeed, the whole Apennine range of transition rocks is distinguished by its great abundance of serpentine and bronzite. The Verde di Prato, from Monte Ferato near Florence, is another example of the same. It occurs also at Leprese, in the Venetian territory; near Hof in Bayreuth; at the Gulsen Mountain in Styria; imbedded in greenstone at the Baste in the Hartz; and in the Lizard district of Cornwall, of a peculiarly dark-brown colour.

## HYPERSTENE.

Prismatoidal Schiller Spar, *M.* Labrador Schiller Spar, *J.* Hypersthene, *P.* Labradorische Hornblende, Paulit, *W.* Hypersten, *L.* Diallage Metalloïde, *H.*

Sp. Gr. 3·3—3·4. H. = 6·0.

Prismatic. Colour greyish- or greenish-black. Opake, with a bright metallic pearly lustre. Streak greenish grey. Cleavage in three directions, two having a silvery lustre, the third a copper tinge. Contains silica 54·25, magnesia 14·00, alumina



2.25, lime 1.50, oxide of iron 24.50, water 1.00, with a trace of manganese—Klaproth. Heated alone, its appearance is scarcely changed, but before the blowpipe upon charcoal it fuses into a greenish-grey opaque globule, and with borax is easily soluble into a greenish glass.

## OBSERVATIONS.

The cleavage of this mineral, which in general may be easily observed, distinguishes it from the preceding. It occurs principally at the island of St Paul's (whence its title of Paulite), on the coast of Labrador, imbedded in a syenitic or greenstone rock; also in Greenland. It occasionally is associated with Labrador felspar, and admits of being cut and polished, presenting in that state a beautiful copper-red colour, and metallic pearly lustre.

## ANTHOPHYLLITE.

Prismatic Schiller Spar, *M.* Anthophyllite, *J. P.* and *H.* Strahliger Anthophyllite, *W.*

Sp. Gr. 3.0—3.3. H. = 5.0—5.5.

Prismatic. *Colour* between grey and dark clove brown. Translucent, with a pearly lustre inclining to metallic. *Streak* white. Brittle. *Cleavage* parallel to the faces of a rhombic four-sided prism of  $124^{\circ} 30'$ . Contains

Silica	56.00	56.0
Alumina	13.30	3.0
Magnesia	14.00	23.0
Lime	3.33	2.0
Oxide of iron	6.00	13.0
Ox. of manganese	3.00	4.0
Water	1.43—John.	0.0—Gmelin.

It is infusible, and *per se* is not altered before the blowpipe; but with borax it melts, though with difficulty, into a grass-green transparent bead.

## OBSERVATIONS.

Anthophyllite occurs in promiscuous fibres, and foliated distinct concretions, of a hair-brown colour, at Kongsberg in Norway; translucent, and of a rich clove-brown colour, at Ujordlersoak in Greenland; and in foliated masses, having a dark-brown metallic hue, with mica, at Snarum, near Modum in Norway.

## KYANITE.

Prismatic Disthene Spar, *M.* Prismatic Kyanite, *J.* Cyanite, *P.* Cyanit, *Rhætizit*, *W.*  
 Disthen, *L.* Disthene, *H.*

Sp. Gr. 3·5—3·7.  $H. = 5\cdot0-7\cdot0$ .

Tetarto-prismatic. FIG. 81. In scalene four-sided prisms; the inclination of *l* to *M* =  $106^{\circ} 15'$ , and of *M* to *T* =  $100^{\circ} 15'$  and  $79^{\circ} 45'$ . *Colour* blue or white prevalent, passing into grey, yellow, red, and even black, from foreign admixture. *Lustre* pearly upon the face *M*, particularly if produced by cleavage, inclining to vitreous on the others. More or less translucent; sometimes even transparent. *Streak* white. *Cleavage* highly perfect, parallel to *M*; also, though not so distinct, parallel to *l* and *T*. Contains

	St Gothard.	
Alumina	64·39	55·50
Silica	34·33	Arfwedson. 43·00 Klaproth.

with occasional admixtures of lime, iron, and water.

It is infusible, and remains unaltered even in very high degrees of temperature. The *Rhætizite* becomes red, but, if farther heated, changes again into white. It is entirely, though slowly, soluble with borax into a transparent colourless glass.

## OBSERVATIONS.

Kyanite and *Rhætizite* were considered distinct species, but they differ merely in colour; the latter referring to those varieties which are perfectly white, the former particularly to such as have a blue tinge. The most distinct and transparent crystals of this mineral are found associated with staurolite in mica slate at St Gothard in Switzerland; but even these rarely present terminal planes. Sometimes it has a pale Berlin blue colour, sometimes is limpid and highly cleavable, as in the Alpine regions of St Gothard, in Styria, and Carinthia. Another fine blue lamellated variety is found in gneiss at Botrifny in Banffshire. Portions of extremely large individuals occur in Bohemia, others at Villa Rica in South America, and at Massachusetts, U. S. The *Rhætizite* is chiefly brought from Kemetten in the Pfitsch Valley, Tyrol, where it occurs in aggregated or stellated crystalline masses of a white or red colour; the dark-grey variety from that locality obtains its hue from an admixture of plumbago. It is also met with in Shetland, and may be distinguished from actynolite, by its infusibility, cleavage, and higher specific gravity. When blue and transparent, and affording sufficiently large masses, it is cut and polished as an ornamental stone, possessing some resemblance to sapphire.



## DIASPORE.

Euklastic Disthene Spar, *Haid.* Diaspore, *J.* and *P.*

Sp. Gr. 3.43—3.6. H. = 6.0—6.5.

Occurs massive or disposed in irregular prisms, having a lamellar structure, and a greenish-grey or hair-brown colour. Translucent when thin, with a brilliant vitreous or pearly *lustre*. *Cleavage* in two directions, parallel to the faces of a rhombic prism of about 130°. Consists of

Alumina	80.00	76.06
Protoxide of iron	3.00	7.78
Water	17.40—Vauquelin.	14.70—Children.

Before the blowpipe it decrepitates with violence, and splits into numerous scaly particles, which with borax fuse readily into a colourless glass. When these particles, after being exposed to a slight ignition, are placed on moistened red turmeric paper, each of them forms a blue spot on the place it covered.

## OBSERVATIONS.

The Diaspore is an extremely rare mineral. It is said to occur only in that part of the Ural mountains, within the Orenbourg government of Asiatic Russia, but under what circumstances has not been ascertained. Its superior lustre distinguishes it from the last species, some varieties of which it much resembles.

## SPODUMENE.

Prismatic Triphane Spar, *M.* Prismatic Spodumene, *J.* Spodumen, *W.* Triphan, *L.* Triphane, *H.*

Sp. Gr. 3.0—3.2. H. = 6.5—7.0.

Massive, with a lamellar structure. *Colour* greyish-green, passing into greenish-white. Translucent. *Lustre* pearly; and *streak* white. Cleavable in two directions parallel to the faces of a rhombic prism of about 93°. *Fracture* uneven. Consists of

	Uton.	Uton.	Killiney.
Silica	66.40	63.29	63.31
Alumina	25.30	28.78	28.51
Lithia	8.85	5.63	5.66
Oxide of iron	1.45 Arfwed.	0.79 Strom.	0.83 Thom.

It loses translucency and colour when exposed to a red heat; and before the blowpipe intumescs, and fuses into a nearly colourless transparent glass.

## OBSERVATIONS.

It occurs accompanying magnetic iron ore, and associated with quartz, tourmaline, and felspar in the island of Uton in Sudermanland, Sweden; also near Sterzing in the Tyrol; and having a pale green or yellowish tinge, imbedded in granite at Killiney Bay near Dublin.

## PREHNITE.

Axotomous Triphane Spar, *M.* Prismatic Prehnite, *J.* Prehnit, *W. L. H. &c.*

Sp. Gr. 2.8—3.0. H. = 6.0—7.0.

Prismatic. FIG. 83. In thin rhomboidal plates. Inclination of *M* to *M* =  $99^{\circ} 30'$ . Colour various shades of green, leek-green, apple-green, siskin-green, passing into colourless, yellow, and grey. Translucent. Lustre vitreous, except upon the face *P*, which is pearly. Streak white. Cleavage very distinct parallel to *P*, less so to *M*. Face *P* streaked parallel to the edges of combination with *M*. Consists of

	C. of Good Hope.	Dumbarton.	Reichenbach.
Silica	43.80	43.60	42.50
Alumina	30.88	23.00	28.50
Lime	18.33	22.33	20.40
Oxide of iron	5.66	2.00	3.00
Water	1.83 Klap.	6.40 Thom.	2.00 Laugier.

It intumesces before the blowpipe, forming a white frothy scoria, and then melts into a compact globule. With borax it fuses into a transparent bead. In dilute muriatic acid it is slowly dissolved, and leaves a flaky residue, but does not gelatinize; and when heated it exhibits electric poles.

## OBSERVATIONS.

Prehnite occurs either fibrous, massive, or in crystals so closely aggregated as to render their forms indeterminable; when in plates this aggregation frequently takes place laterally; and if in that case they diverge from a centre, the peculiar rounded cock's-comb or fan shape (the *Flabelliforme* of Haüy) is produced. It was first known in bright apple-green coloured specimens from the Cape of Good Hope, whence it was brought to Europe by Colonel Prehn, whose name it has retained. Since that period, it has been found both crystallized in tabular plates, and in flabelliform aggregations of a peculiar bluish-green colour, associated with axinite and epidote, at St Christophe in Dauphiné; in large well formed crystals of a pale green hue in the Fassa Valley, Tyrol; in Salzburg, Carinthia, Sweden, &c. At Friskie Hall and Campsie in Dumbartonshire, and at Hartfield Moss in Renfrewshire, it is found extensively in



veins traversing trap, associated with analcime and Thomsonite; as also at Corstorphine Hill, the Castle, and Salisbury Crag, near Edinburgh. The Scotch varieties occasionally present very beautiful modifications, though in general they appear in radiated, botryoidal, orbicular, or mammillated masses of various colours, from apple-green to straw-yellow, the latter particularly at Salisbury Crag; sometimes translucent and colourless, as at the Castle Hill; and very often white and opaque, as in Dumbartonshire. Large compact masses have been brought from China, which, when cut and polished, form handsome slabs.

The tendency of its crystals to unite in such a manner as to produce rounded forms is very characteristic; and though most remarkable in the splendid specimens from Dauphiné, is not peculiar to any one variety.

### DATOLITE.

Prismatic Dystome Spar, *M.* Prismatic Datolite, *J.* Borate of Lime, *P.* Datholith, *W.* Esmarkite, *Haus.* Datolith, *L.* Chaux Boratée Siliceuse, *H.* Humboldtite, *Levy.*

Sp. Gr. 2.8—3.0. H. = 5.0—5.5.

Hemi-prismatic. FIG. 84. Inclination of *b* to *s* =  $91^{\circ} 41'$ , of *g* to *g* over *s* =  $116^{\circ} 9'$ , of *f* to *f* contiguous =  $102^{\circ} 30'$ . Colour white, inclining to grey and yellow. More or less translucent. Lustre vitreous, inclining to resinous in the fracture. Streak white. Cleavage parallel to *f* and *s*, not very distinct.

Consists of		<i>Botryolite.</i>	Hartz.
Silica	36.50	36.00	38.51
Lime	35.50	39.50	35.59
Boracic acid	24.00	13.50	21.34
Oxide of iron	0.00	1.00	0.00
Water	4.00 Klap.	6.50 Klap.	4.60 Du Menil.

On exposure to the flame of a candle it becomes friable, and crumbles down between the fingers. Before the blowpipe it intumesces, and melts into a transparent or pale rose-coloured globe. It dissolves easily in, and gelatinizes with, nitric acid. With bisulphate of potash and fluor, its powder presents the usual indications of boracic acid.

### OBSERVATIONS.

The *Humboldtite* described by Levy, and the *Botryolite* or botryoidal datolite of Haüy, both belong to this species. Very interesting crystallizations of datholite occur in greenstone in New Jersey, U. S.; at Arendal in Norway; at Andreasberg in the Hartz; in the island of Uton, Sweden; and in the valley of Glen Farg, Perthshire. The *Humboldtite* is found in agate balls at the Seiser Alp in the Tyrol; the *botryolite* in gneiss near Arendal in Norway.

## LEUCITE.

Trapézoidal Kouphone Spar, *M.* Dodecahedral Zeolite or Leucite, *J.* Leuzit, *W.* and *L.* Amphigène, *H.*

Sp. Gr. 2·4—2·5. H. = 5·5—6·0.

Tessular. FIG. 15. Inclination of  $a$  to  $a = 146^{\circ} 27'$ , of  $a$  to  $a' = 131^{\circ} 49'$ . Colour ash-grey or smoke-grey, greyish-white, or reddish. Translucent, with vitreous lustre. Streak white. Fracture conchoidal, and cleavage very imperfect. Composed of

	Vesuvius.	Albano.	
Silica	53·75	54·0	56·10
Alumina	24·62	23·0	23·10
Potash	21·35	22·0	21·15

Oxide of iron 0·00 Klap. 0·0 Klap. 0·90 Arfwedson.

The Berzelian formula indicates 20·89 potash, 22·76 alumina, and 56·35 silica. Alone it is infusible before the blowpipe ; but with borax or carbonate of lime it melts, though with difficulty, into a clear globule. Reduced to powder it changes the colour of the blue tincture of violets into green.

## OBSERVATIONS.

Leucite, in grains or indistinct crystals, is very common among the ejected scorïæ of Vesuvius. The well-known tetragonal-icositetrahedrons (fig. 15), in which form only it occurs, and of which some splendid specimens are preserved in the College Museum of Edinburgh, are met with imbedded in the more ancient lavas of Vesuvius. In these they appear either so slightly attached as to be easily disengaged, or, from withstanding the action of the weather better than their matrix, fall out on exposure. In the vicinity of Rome, at Borghetto some miles to the north, and at Albano and Frascati to the south, some of the older lavas are so thickly studded with this mineral as to appear almost entirely composed of it ; and in Italy, for the last two thousand years at least, that variety has been used in the formation of mill-stones, as the late excavations at Pompeii demonstrate. The ancient lavas of the Rieden country, between the Laacher See and Andernach on the Rhine, also contain small, but distinctly-pronounced, imbedded crystals of leucite. Particles of extraneous matter, such as crystals of augite and hornblende, and sometimes even portions of the same lava in which they are imbedded, frequently appear within the crystals when fractured. This mineral is remarkable in the history of chemical discovery, as the first in which Klaproth observed the presence of potash.



## SODALITE.

Dodecahedral Kouphoné Spar, *M.* Dodecahedral Zeolite or Sodalite, Hauyne, Spinellane, Azurestone, Lapis Lazuli, *J.* and *P.* Lazurstein. *W.* Nosin, Sodalit, *L.* Sodalite, Lazulite, *H.* Sodalite, Auina, *Monticelli.*

Sp. Gr. 2·25—3·0. H. 5·5—6·0.

Tessular. FIG. 11. Dodecahedron. Colour various. More or less translucent. Streak white or bluish. Cleavage parallel to the faces of the dodecahedron. Fracture conchoidal, or uneven. The varieties of this species contain the following ingredients, though the analyses of different chemists present by no means similar proportions.

	<i>Sodalite</i> from Greenland.		Vesuvius.
Silica	36·00	38·52	35·99
Alumina	32·00	27·48	32·59
Soda	25·00	23·50	26·55
Muriatic acid	6·75	3·00	5·30
Lime	0·00	2·70	0·00
Oxide of iron	0·25 Eckeberg.	1·00 Thom.	0·00 Arfwed.
	<i>Hauyne.</i>	<i>Spinellane.</i>	<i>Lapis-lazuli.</i>
Silica	35·48	43·0	49·0
Alumina	18·87	29·5	11·0
Soda	0·00	19·0	8·0
Potash	15·45	0·0	
Lime	12·00	1·5	16·0
Oxide of iron	1·16	2·0	4·0
Sulph. acid	12·39	1·0	2·0
Water	1·20 Gmelin.	2·5 Klap.	a trace. Gmelin.

These varieties comport themselves as differently before the blowpipe as their varied constituents would lead us to expect; they however all gelatinize with nitric acid.

## OBSERVATIONS.

The union of Hauyne, Spinellane, and Lapis-lazuli, with Sodalite, though proposed by Bergemann, Noggerath, and other mineralogists besides Mohs, appears extremely anomalous, for there are few minerals included in the order spar which bear less apparent analogy. None of their characters, it is true, are sufficiently marked to admit of an accurate line of distinction being drawn between them; but so heterogeneous an assemblage being more likely to confuse than to simplify, we shall shortly describe each variety separately.

Of the *Sodalite* properly so called, there are two kinds: *First*, that

noticed by my father in Gièsécke's Greenland collection, and so named by Dr Thomson, from the large proportion of soda it afforded on analysis (Royal Society Trans. Edin. vi. 387); and, *Second*, the Vesuvian variety, which occurs in white, translucent, dodecahedral crystals of considerable magnitude, sometimes elongated into six-sided prisms, imbedded in or coating the cavities of volcanic rocks. The former is associated with felspar, arfwedsonite, eudyalite, and augite, and occurs both in distinctly pronounced crystals, and in masses in which these crystals are imbedded; its colour is green unless newly fractured, when it presents a brilliant pink tinge, but this on exposure to light goes off in a few hours; its specific gravity amounts to 2.29; and it is partly fused, though with extreme difficulty, in the reducing flame of the common blowpipe, although when urged by the gas blowpipe, it intumesces, and is ultimately converted into a white enamel; it is found in the Kangerdluarsukfiord, West Greenland. The Vesuvian variety is accompanied with nepheline, pleonaste, idocrase, and other volcanic species; before the blowpipe it forms a colourless glassy globule, and it weighs specifically 2.38. Massive sodalite of a grey colour likewise occurs, imbedded in trap, at the Kaiserstuhl in the Brisgau.

*Haüyne* possesses a fine blue or occasionally an asparagus-green colour, and is also met with crystallized; either disposed in the cavities of volcanic debris, as at Vesuvius, and in the vicinity of Rome; or imbedded in lava or pumice, as at Niedermannich near Andernach on the Rhine. It may be distinguished from lazulite by its vitreous lustre, a character which the latter does not possess. Before the blowpipe *per se* it fuses slowly into an opaque mass, and with borax effervesces and forms a transparent vitreous globule, which becomes yellow on cooling. It possesses a specific gravity between 2.68 and 3.0, and does not gelatinize with acids so easily as the others.

The *Spinellane*, or *nosian* of Klaproth, occurs in dark ash-grey translucent crystals, disposed in the drusy cavities of glassy felspar, at the lake of Laach, near Andernach on the Rhine. It is infusible before the blowpipe, and has a specific gravity of 2.28.

*Lapis-lazuli*, formerly distinguished by Mohs under the title of dodecahedral azure spar (Haid. Translation, II. 288), is rarely met with otherwise than massive; it presents a rich Berlin or azure blue colour, granular structure, and a rough uneven fracture. Before the blowpipe it fuses into an opaque globule; and, if previously calcined and reduced to powder, loses its colour in acids; specific gravity 2.95. Persia, China, Siberia, and Bucharia are its principal localities, being there found associated with felspar and limestone, and having scales of mica and specks of pyrites frequently mixed throughout its mass; on the banks of the Indus it occurs disseminated in greyish limestone. The lapis-lazuli, when of an intense blue colour, is prized by the lapidaries, particularly in Italy, where the larger masses are chiselled into vases, or sliced and made up into tables and other pieces of ornamental furniture. I have seen in Rome a richly coloured, compact, and perfectly homogeneous block of this sub-



stance, exceeding the dimensions of a cubic foot, which one of our wealthy countrymen purchased, and caused to be formed into a peculiarly handsome sarcophagus-shaped vase. The Orlof palace, built by Catherine II. at St Petersburg, was decorated with lapis-lazuli in the greatest profusion; many of the Roman churches contain magnificent slabs of it; and it is still largely employed in the manufacture of mosaics at Florence. The fragments of the mineral thus used are carefully preserved for the sake of the ultramarine, which is extracted from it in a pounded state. (See Azure stone in Ure's Chemical Dictionary); but there are several modes also of manufacturing it artificially. Ann. de Chimie, April 1828.

## ANALCIME.

Hexahedral Kouphone Spar, *M.* Hexahedral Zeolite or Analcime, *J.* Cubizit, *W.*  
Analzim, *L.* Analcime, *H.*

Sp. Gr. 2.0—2.2. H. = 5.5.

Tessular. FIG. 85. Form *tri-épointé* of Hauy. Inclination of P to o =  $144^{\circ} 44'$ . Colour commonly white, passing into grey or reddish-white. Transparent, translucent, or almost opaque. Lustre vitreous. Streak white. Cleavage imperfect.

Contains,	Fassa.	Kilpatrick.
Silica	55.12	55.07
Alumina	22.99	22.22
Soda	13.53	13.71
Water	8.27—Rose.	8.22—Connell.

with which the Berzelian formula closely corresponds. It gelatinizes in muriatic acid, and upon charcoal fuses without intumescence into a diaphanous glass. It becomes slightly electric when heated, and derives its name from the feebleness of this property.

## OBSERVATIONS.

The most perfectly pellucid crystals of this mineral are brought from the Cyclopean Islands, on the coast of Sicily, near Catania. They, as well as most of those from the Tyrol, present the form *tri-épointé*, fig. 85; while the only crystalline form met with in Dumbartonshire, Glen Farg, and other Scottish localities, is that of the icositetrahedron, fig. 15. These in general are more or less white and opaque, occurring in crystals sometimes three or four inches in diameter. Large individuals extremely similar in appearance are found at the Seisser Alp in the Tyrol. In the Faroe Islands, Iceland, several of the Hebrides, the Vicentine, and elsewhere among the cavities of amygdaloidal, basaltic, and trap rocks, analcime is of frequent occurrence, associated with prehnite, chabasie, apophyllite, &c. At the Giant's Causeway it is found in

basalt; at Arendal in Norway in beds of iron ore; and, though less frequently, in silver veins at Andreasberg in the Hartz. The optical structure of this mineral observed by Sir David Brewster (Royal Society Trans. x. 187) is extremely remarkable.

### SARCOLITE.

Octahedral Kouphone Spar, *Haid.* Sarcollithe de Thomson, *H.*

H. about 5·0.

FIG. 86. Inclination of P to  $n = 125^\circ 16'$ . Colour pale flesh-red, or brownish-white. Semi-transparent. Lustre and fracture vitreous. Very brittle.

#### OBSERVATIONS.

This mineral, from its hardness and vitreous aspect, was classed by Haüy with analcime; but the combination of the octahedron and cube, under which form it occurs, never having been observed in the latter substance, rendered their separation unavoidable. It is found among the anciently ejected debris of Vesuvius, associated with wollastonite, hornblende, and others of the zeolite family; being extremely brittle and full of flaws, it splits and falls to pieces unless carefully handled. It was discovered and named by the late Dr Thompson of Naples, and is designated by Monticelli *analcime carnea*; the analysis, however, given both by him and Haüy, refers to Gmelinite.

### HARMOTOME.

Paratomous Kouphone Spar, *J.* Pyramidal Zeolite or Cross Stone, *J.* Staurolite, *Kirwan.* Harmotome, *P.* Kreuzstein, *W.* Harmotom, *L.* Harmotome, *H.*

Sp. Gr. 2·3—2·4. H. = 4·5.

Prismatic. FIG. 87. Generally in twin crystals. Inclination of P to P =  $121^\circ 58'$ . Colour commonly white, passing into grey, yellow, and brown. Semi-transparent or translucent. Lustre vitreous. Streak white. Cleavage parallel to  $q$  and  $o$ , imperfect. Consists of

	Andreasberg.		Strontian.
Silica	49·0	48·73	47·04
Alumina	16·0	15·10	15·24
Baryta	18·0	14·27	20·85
Lime	0·0	3·18	0·10
Potash	0·0	2·55	0·88
Water	15·0 Klaproth.	9·35 Thomson.	14·92 Connell.

Mr Connell also noticed 0·88 of soda.



Before the blowpipe, both alone and with borax, it melts slowly without intumescence, into a clear globule. When thrown on heated coal, in the form of powder, it phosphoresces with a yellow light; and is not easily acted upon by acids unless they are heated.

## OBSERVATIONS.

The finest simple crystals of this mineral occur disposed on calcareous spar at Strontian in Argyleshire, where individuals of a pure white colour have been met with nearly an inch in diameter. The cross-stone, or maced variety, is found at the same place, although it is more commonly known from Andreasberg in the Hartz, in metalliferous veins traversing grauwacke. It also occurs coating the cavities of siliceous geodes at Oberstein in Deuxponts; on gneiss at Kongsberg in Norway; and occasionally accompanying analcime in the amygdaloid of Dumbartonshire. Kirwan's name of *Staurolite* particularly referred to the cruciform variety from Andreasberg.

## PHILLIPSITE.

Staurotypous Kouphone Spar, *M.*

Sp. Gr. 2.0—2.2. H. = 4.5.

Prismatic. FIG. 88. *Form and cleavage* similar to those of Harmotome. *Colour* white. Translucent, or opaque. Contains silica 48.02, alumina 22.61, potash 7.50, lime 6.56, water 16.75—Variety from Marburg, by Gmelin.

## OBSERVATIONS.

Phillipsite much resembles the last species, and is not easily distinguished from it without ascertaining the specific gravity. Neither Wollaston nor Gmelin found the slightest trace of baryta in it; but instead of that ponderous earth, whose presence may account for the higher specific gravity of harmotome, phillipsite contains considerable portions of lime and potash. It occurs in large translucent crystals in the cavities of amygdaloid, at the Giant's Causeway in Ireland; forming groups or sheaf-shaped aggregations at Capo di Bove near Rome; at Aci Reale on the eastern coast of Sicily, Marburg in Hessa, Lowenstein in Silesia, and among the lavas of Vesuvius. The specimens from Aci Reale present elongated crystals, which adhere closely together, and radiate from a centre in globular concretions. Of late it has been found with gmelinite, in the island Magee, county Antrim, in minute flesh-red coloured crystals, coating cavities of amygdaloid. This species has been described under the denomination of lime-harmotome. Connell, in Edin. New Phil. Jour. July 1832.

## CHABASIE.

Rhombohedral Kouphone Spar, *M.* Rhombohedral Zeolite or Chabasite, *J.* Chabasie, *P.* Schabasit, *W.* Chabasin, *Haus.* Chabasie, *L.* and *H.*

Sp. Gr. 2.0—2.1.  $H. = 4.0—4.5.$

Rhombohedral. FIG. 1. *Form* an obtuse rhomb whose angles are equal to  $94^{\circ} 46'$  and  $85^{\circ} 14'$ . *Colour* almost constantly white. Transparent, semi-transparent, or translucent. *Lustre* vitreous. *Streak* white. *Cleavage* pretty distinct parallel to the faces of the rhomb. *Fracture* uneven. Contains,

	Gustafsberg.	Faroe.	Kilmalcolm.
Silica	50.65	48.30	50.14
Alumina	17.90	19.28	17.48
Lime	9.73	8.70	8.47
Potash with soda	1.70	2.50	2.58
Water	19.50 Berz.	20.00 Arfwed.	20.83 Connell.

It is not acted upon by acids, but before the blowpipe fuses readily into a white spongy-like mass. The opaque crystals become translucent when dipped in oil.

## OBSERVATIONS.

Large and very beautiful crystals of chabasie are found in the amygdaloidal rocks of Faroe, Iceland, and Greenland, often associated with stilbite and green earth. Splendid specimens occur in a kind of greenstone rock (the graustein of Werner) at Aussig in Bohemia. Smaller, but transparent varieties, are met with in the cavities of basalt at the Giant's Causeway; disposed on trap, and accompanied with stilbite, at Kilmalcolm, Renfrewshire; in the Isle of Skye, and elsewhere in the west of Scotland; also at Gustafsberg in Sweden, in the agate balls of Oberstein in Deuxponts, and at Husavic in Iceland in small transparent crystals filling the cavities of the fossil Venus Islandica. It does not occur massive. The *Mesoline* of Berzelius (*Edin. Phil. Jour.* VII. 7) refers apparently to a variety of Chabasie.

## LEVYNE.

Macrotypous Kouphone Spar, *M.* Levyne, *Brewster*, *Journal*, II. 552.

Sp. Gr. 2.0—2.2.  $H. = 4.0.$

Rhombohedral. FIG. 89. Inclination of  $P$  to  $P' = 125^{\circ} 12'$ , of  $o$  to  $g = 136^{\circ} 1'$ , of  $o$  to  $P = 117^{\circ} 24'$ . *Colour* white. Semi-transparent. *Lustre* vitreous. *Streak* white. *Cleavage*



indistinct, parallel to the faces of a rhomb of  $79^{\circ} 29'$ . *Fracture* imperfect conchoidal. *Brittle*.

Upon charcoal it intumesces, and with salt of phosphorus yields a transparent globule, which contains a skeleton of silica, and becomes opake on cooling. In the glass tube it gives off a considerable quantity of water, whitens, and becomes opake; but is neither soluble in acids, nor does it gelatinize with them.

## OBSERVATIONS.

Sir David Brewster subjected this mineral to optical examination, and named it in compliment to Mr Levy, who had previously examined its crystallographic properties. It occurs disposed in cavities of trap, associated with acicular and radiated mesotype, at the little Deer Park of Glenarm, county Antrim; also at Skagastrand in Iceland; at Dalsnypen in Faroe; Godhavn in Disco Island, Greenland; in the Vicentine; and, though rarely, in large reddish-coloured opake crystals at Hartfield Moss in Renfrewshire—a solitary twin crystal of considerable size from this locality being preserved in my father's collection. The Berzelian analysis of this mineral refers to chabasie.

## GMELINITE.

Hexagonal Kouphone Spar, *Haid.* Hydrolite, *De Dree.* Sarcolite, *Vauquelin.* Gmelinite, *Brewster, Journal*, II. 262.

Sp. Gr. 2.0—2.1. H. = 4.5.

Rhombohedral. FIG. 90. Flat six-sided prisms terminated at both ends by truncated six-sided pyramids. Inclination of  $y$  to  $y'$  over  $u = 83^{\circ} 36'$ . *Colour* white, passing into flesh-red. *Translucent*. *Lustre* vitreous. *Streak* white. *Cleavage* distinct parallel to the faces of a rhomb. *Fracture* uneven. Surface of the prism streaked horizontally. Contains,

	Castel.	Antrim.
Silica	50.00	39.89
Alumina	20.00	12.97
Lime	4.25	0.00
Soda	4.25	0.00
Water	20.00	29.86
Potash	0.00	9.82
Protoxide of iron	0.00	7.44 Thomson.

It possesses the property, when held in the flame of a candle, of flying off in numerous scales. "Small portions," says Sir David Brewster, "gradually raise themselves, and after standing on their

ends as if they were under the influence of electricity, they are propelled with violence from the fragment." The continued application of heat drives off its water of crystallization, and reduces the fragment to a white fibrous looking powder.

## OBSERVATIONS.

The *Sarcolite* of Vauquelin, which, however, differs materially from the sarcolite of Thompson (see p. 116), the *Hydrolite* of De Dree, and the *Gmelinite* of Brewster, are merely different names of the same mineral. It occurs coating the cavities of amygdaloidal rocks, at Montecchio Maggiore and Castel in the Vicentine, and in the county Antrim; in the latter of a white colour at the Deer Park of Glenarm, and presenting a pale flesh-red tinge at the Island Magee near Larne. The name of Gmelinite was proposed by Sir David Brewster in compliment to G. C. Gmelin, professor of chemistry in the university of Tübingen.

## LAUMONITE.

Diatomous Kouphone Spar, *M.* Di-prismatic Zeolite or Laumonite, *J.* Lomonit, *W.* Laumontit, *L.* Laumonite, *H.*

Sp. Gr. 2.3—2.4. H. above 4.0 when fresh.

Hemi-prismatic. FIG. 23. An oblique rhombic prism. Inclination of P to M =  $113^{\circ} 30'$ , of M to M =  $86^{\circ} 15'$ . Colour white, passing into yellow or grey. Transparent or translucent, becoming opaque on exposure. Lustre vitreous, inclining to pearly on the more distinct faces of cleavage. Streak white. Cleavage distinct parallel to a face which bevels the acute edge. Consists of,

	Huelgoet.	Skye.
Silica	48.30	52.04
Alumina	22.70	21.14
Lime	12.10	10.62
Water	16.00—Gmelin. 14.92—Connell.	

Before the blowpipe it intumesces and melts into a white spumous mass, and with borax forms a transparent globule. It gelatinizes with nitric or muriatic acid, but is not affected by sulphuric acid unless heated.

## OBSERVATIONS.

As Laumonite loses its water and is decomposed on exposure to the atmosphere, it commonly occurs either white and opaque with a shining pearly lustre, or perfectly friable. It was noticed in 1785 at Huelgoet in Brittany by Gillet Laumont, after whom it is named; and since



then in Iceland in minute crystals disposed on calcedonic quartz, which decompose less than those of other varieties. It occurs also in the Faroe Islands; at Disko in Greenland; at St Gothard in Switzerland; forming large masses which exhibit a radiating and divergent structure in the Fassa-thal; accompanying analcime at Hartfield Moss in Renfrewshire; and in several trap rocks of the Hebrides and north of Ireland. To counteract the rapid decomposition which takes place in this mineral when exposed to air, its specimens are often dipped into a thin solution of gum-arabic.

## NATROLITE.

Prismatic Kouphone Spar, *M.* Prismatic Zeolite or Mesotype, *J.* Mesotype, *P.* Faser-zeolith, Natrolith, *W.* Mesotype, *H.*

Sp. Gr. 2.2—2.3. H. = 5.0—5.5.

Prismatic. FIG. 91. Inclination of *o* to *M* =  $116^{\circ} 40'$ , of *e* to *M* =  $117^{\circ} 14'$ , of *M* to *M* =  $91^{\circ}$ . Colour white, inclining to yellow, sometimes red. Transparent or translucent. Lustre vitreous. Cleavage perfect parallel to *M*. According to Gehlen and Fuchs, it contains,

	Hohentwiel.	Tyrol.
Silica	47.21	48.63
Alumina	25.60	24.82
Soda	16.12	15.69
Water	8.88	9.60
Oxide of iron	1.35	0.21

Corresponding to the chemical formula for 15.93 soda, 26.19 alumina, 48.64 silica, and 9.24 water. Before the blowpipe it becomes opaque, and melts into a glassy globule. It is difficultly fusible with borax; but is soluble in, and forms a thick jelly with acids.

## OBSERVATIONS.

The name of Natrolite was formerly applied peculiarly to that variety which occurs in mamillary masses at Hohentwiel in Swabia, and which when broken presents a fibrous radiating structure, tinged in concentric rings, with alternate zones of white, yellow, or reddish-brown. The large well-pronounced crystallized zeolite from Auvergne has however been ascertained to belong to the same species, and, in form at least, differs materially from the following, with which it used to be confounded. The same mineral occurs in delicately diverging prisms in the *graustein* of Aussig in Bohemia; in the trap rocks of Kilmalcolm in Renfrewshire, and Glenarm in the county Antrim; and in radiating groups of a fine red colour on the Duron in the Fassa valley.

## MESOTYPE.

Peritomous Kouphone Spar, *Haid.* Zeolith, *W.* Mesotype, *P.* (Mesotype from Faroe.)

Sp. Gr. 2.2—2.3. H. = 5.0—5.5.

Prismatic. FIG. 92. In four-sided prisms, which are slightly rhombic, terminated by four-sided pyramids. Inclination of M to M =  $91^{\circ} 28'$ . Colour white or greyish-white. The crystals transparent or translucent. Lustre vitreous. Cleavage perfect parallel to M, the faces of the prism. Contains silica 54.46, alumina 19.70, soda 15.09, lime 1.61, water 9.83—Gehlen. Before the blowpipe the crystals become opaque, and form a glassy globule without intumescence. With borax it fuses difficultly.

## OBSERVATIONS.

This beautiful mineral presents very different aspects; sometimes occurring in fine transparent crystals an inch or two in length, frequently fibrous and pulverulent, and occasionally in extremely tough compact masses in which the structure is scarcely visible. The crystalline varieties are principally found, forming diverging groups, in the vesicular cavities of amygdaloid in the Faroe Islands; these in their natural state are coated with a thin film of bituminous matter, which however may be removed by washing in dilute nitric acid, without materially injuring their natural aspect. In the trap rocks of the Giant's Causeway and the Hebrides, also in Greenland and Faroe, these crystals are so delicately acicular as to produce almost a down-like coating. When aggregated in radiating or stellular forms, the *fibrous* variety is produced, the centre of which, from its compactness, often yields a splintery fracture, while the surrounding part is soft and apparently decomposing. The pulverulent or *mealy* zeolite of Jameson occurs in soft, dull, friable masses, having an earthy fracture, a rough and meagre feel, and a white, greyish, or red colour. Mesotype occurs disposed in trap tuff and associated with analcime at Montecchio Maggiore in the Vicentine; in small silky-like diverging tufts coating cavities of lava in the more ancient portions of Vesuvius; radiated and mamillated at Hauenstein in Bohemia, and elsewhere on the continent.

## SKOLEZITE.

Harmophanous Kouphone Spar, *Haid.* Mesolite, Needlestone, *P.* Mesolite, *Levy.* (Mesotype from Iceland).

Sp. Gr. 2.2—2.3. H. = 5.0—5.5.

Hemi-prismatic. FIG. 93. In twin crystals joined in the di-



rection of the axis. Inclination of  $o$  to  $o = 145^\circ 10'$ , of  $o$  to  $o'$ ,  $= 179^\circ 0'$ , of  $o$  to the face  $o'$  on the opposite side of the crystal  $= 141^\circ 53'$ , of  $M$  to  $M = 91^\circ 25'$ . The prisms are translucent or transparent, and colourless, shining externally with a somewhat pearly lustre.

	Iceland.	Faroe.
Silica	47.00	46.80
Alumina	25.90	26.50
Lime	9.80	9.87
Soda	5.40	5.40
Water	12.30 Gehlen.	12.30 Berzelius.

Before the blowpipe it becomes opake, curls up, and finally melts, with the extrication of air bubbles, into a porous and almost opake bead. It dissolves readily in acids, forming a thick gelatinous mass; and becomes electric when heated.

## OBSERVATIONS.

Splendid groups of slender transparent crystals were some years ago brought to this country by Menge from Tiegerhottuet in the Beruford, Iceland; these often exceed two inches in length, and are occasionally a quarter of an inch thick; they diverge from a centre, and interlace in the most beautiful manner; but, from their brittle nature, are difficultly transportable. This species has been found in colourless transparent radiated masses, also compact and opake, in the trap district of the Vendayah Mountains in Hindostan, in Greenland, Bohemia, and at Pargas in Finland.

The specific gravity and hardness of this and the two preceding species are identical; but they are distinct both in crystalline form and composition. Natrolite contains no lime, skolezite about ten per cent. of it; in natrolite there is at least fifteen per cent. of soda, in skolezite not more than five, and mesotype contains several per cent. of silica more than either. These species are distinguished from others of the zeolite family by their easy solubility in acid, and by their forming with it a gelatinous mass. The best mode of ascertaining this is to pour some nitric acid upon the mineral previously reduced to powder, which shortly yields a mass, in aspect and consistence like calves-foot jelly.

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My father's collection contains very magnificent and highly characteristic groups of these species; the Faroe varieties in particular, of which he procured some unique specimens when visiting these islands in the summer of 1812.

## THOMSONITE.

Orthotomous Kouphone Spar, *M.* Thomsonite, *P.*

Sp. Gr. 2·35—2·4. H. = 5·0.

Prismatic. FIG. 94. Inclination of *M* to *M* =  $90^{\circ} 40'$ . Generally in masses having a columnar composition. *Colour* white, with a vitreous or rather pearly lustre. Translucent in the mass, transparent when in small fragments. *Cleavage* very easily obtained parallel to *s* and *r*, the faces of a rectangular four-sided prism. Brittle. Consists of

	Lochwinnoch.	Kilpatrick.
Silica	36·80	38·30
Alumina	31·36	30·20
Lime	15·40	13·54
Soda	0·00	4·53
Water	13·00 Thomson.	13·10 Berzelius.

with a little magnesia and iron.

It intumesces before the blowpipe, and becomes snow-white and opaque, but does not fuse. When exposed to a red heat it gives off water, loses about thirteen per cent. in weight, and becomes white and shining.

## OBSERVATIONS.

This mineral was long classed with mesotype or needlestone, from which however it differs as well in cleavage and form as in composition. It was distinguished and named by Brooke, in honour of Dr Thomson of Glasgow. It occurs generally in masses having a fibrous radiated structure, imbedded in trap, and accompanied with analcime and prehnite, at Kilpatrick in Dumbartonshire. Distinct crystals are rarely met with, but indications of the above form may occasionally be observed in the cavities.

## COMPTONITE.

Comptonitic Kouphone Spar, *Haid.* Comptonite, *P.* *Brewster* in *Edin. Phil. Jour.* IV. 131, and VI. 112.

Sp. Gr. 2·35—2·4. H. = 5·0—5·5.

Prismatic. FIG. 95. Inclination of *c* to *c* =  $175^{\circ} 35'$ , of *d* to *d* over *T* =  $89^{\circ}$ . *Colour* white. Transparent or translucent. *Lustre* vitreous. *Streak* white. *Cleavage* parallel to *T* and *M*.



Before the blowpipe it gives off water, intumesces slightly, becomes opake, and then fuses imperfectly into a vesicular glass. The globule obtained with borax is transparent, but vesicular; that with salt of phosphorus contains a skeleton of silica, and becomes opake on cooling. It gelatinizes when exposed in powder to the action of nitric acid.

## OBSERVATIONS.

The name of Comptonite was proposed by my father in honour of Lord Compton, who discovered this mineral among the vesicular lava of Vesuvius, associated with capillary mesotype and other-species of the zeolite family. Since that period it has been met with disposed in basalt at the Pflaster Kaute, near Eisenach in Hessa; forming a thin coating on the surface of mesotype, and occupying the cavities of *graustein* at Leitmeritz and Hauenstein in Bohemia; and associated with analcime and phillipsite at the Cyclopean Islands, Sicily.

## STILBITE.

Prismatoidal Kouphone Spar, *M.* Prismatoidal Zeolite or Stilbite, Radiated Zeolite, *J.* Strahlzeolith, *W.* Blattrich-strahliger Stilbit, *Haus.* Stilbit (in part), *L.* and *H.*

Sp. Gr. 2.0—2.2. H. = 3.5—4.0.

Prismatic. FIG. 96. Inclination of *r* to *r* = 114°, of *r* to *r* on the opposite side = 119° 15. Prevalent colour white, also yellow, red, and brown. Translucent more or less. *Lustre* vitreous except on the faces T, which, both as faces of crystallization and of cleavage, exhibit a pearly lustre. *Streak* white. *Cleavage* highly perfect, parallel to T. Consists of,

Red from Dumbarton.

Silica	58.00	58.3	52.50
Alumina	16.10	17.5	17.37
Lime	9.20	6.6	11.52

Water 16.40 Hisinger. 17.5 Meyer. 18.45 Thomson.

Its chemical formula corresponds to 8.77 lime, 15.82 alumina, 58.78 silica, and 16.63 water. It intumesces before the blowpipe, and yields a colourless glass; but does not at first gelatinize with acids, though, after long exposure to and frequent boiling in nitric acid, a thin jelly is produced.

## OBSERVATIONS.

The principal repositories of this and the following species, which closely correspond in their geographical position, are the vesicular cavities of amygdaloidal rocks, and certain metalliferous veins. In trap

they are frequently accompanied by green earth, as in the Faroe Islands and Iceland, the great localities, as they may well be considered, of this beautiful mineral; also in the island of Skye, where the crystals being usually devoid of the face *r*, exhibit flat four-sided prisms. At Andreasberg in the Hartz, and Kongsberg and Arendal in Norway, where they occur in silver veins and beds of iron-ore, the crystals are smaller and less distinctly pronounced. Some of the Faroe varieties present macle crystals, occasionally so united as to produce cruciform or stellated appearances, and not unfrequently sheaf-like aggregations. Large translucent individuals with a red tinge have been brought from Indore in the Vendayah Mountains, Hindostan. Beautiful crystals of a brick-red colour occur in porphyritic amygdaloid near Kilpatrick in Dumbartonshire, also in the Fassa valley, Tyrol. At Kilmalcolm in Renfrewshire, it is usually of a brown colour, often in stellated groups, disposed with chabasie on decomposed porphyry; and at the copper mine of Gustafsberg near Fahlun in Sweden, a similar variety is met with on granite. Stilbite also occurs in Arran, and at St Christophe in Dauphiné.

It may be distinguished with facility from the foregoing species by its not being readily acted upon by acids. The pearly lustre of its faces have frequently the aspect of selenite, but its superior hardness precludes mistake.

#### HEULANDITE.

Hemi-prismatic Kouphone Spar, *M.* Hemi-prismatic Zeolite, Foliated Zeolite, *J.* Heulandite, *P.* Blatterzeolith, *W.* Blattriger Stilbit, *Haus.* Stilbit (in part), *L.*

Sp. Gr. 2.0—2.2. H. = 3.5—4.0.

Hemi-prismatic. FIG. 97. Inclination of *s* to *s'* = 129° 40', of *s'* to *T* = 116° 20', of *s* to *T* = 114°. *Colour* commonly white, passing into red, grey, and brown; varying from semi-transparent, to translucent only on the edges. *Lustre* vitreous except on *M*, which is eminently pearly both as a face of crystallization and of cleavage. *Streak* white. *Cleavage* highly perfect parallel to *M*. Contains,

	Red from Tyrol.	From Campsie.	White from Faroe.
Silica	52.6	59.95	59.14
Alumina	17.5	16.87	17.92
Potash	9.0	7.19	7.65

Water 18.5 Vauq. 15.40 Walmstadt. 15.10 Thomson.

Before the blowpipe and with acids, it affords nearly the same results as the last species.



## OBSERVATIONS.

Like stilbite, its finest varieties and most beautiful crystals occur in the amygdaloidal rocks of Iceland and Faroe. Splendid specimens have also been brought from the Vendayah Mountains, in Hindostan. Campsie in Stirlingshire, and the Fassa valley, are the localities of the red kind, which, generally speaking, is more common at these places than stilbite of the same colour; at Arendal it occurs of a brown hue, but both there and in the Hartz is less frequent than stilbite. Probably from its being so constantly associated with the last species, it was mistaken by Haüy for a variety of that mineral; it however differs in almost every particular, and may at once be distinguished by its peculiar form, and the superior pearly lustre of its lateral faces, both of crystallization and of cleavage.

## EPISTILBITE.

Diplogenic Kouphone Spar, *Haid.* Rose in Brewster's Jour. IV. 283.

Sp. Gr. 2.2—2.25. H. = 4.0—4.5.

Prismatic. FIG. 98. In obtuse rhombic prisms terminated by two planes set on the acute edges; inclination of *s* to *s* =  $147^{\circ} 40'$ , of *M* to *M* =  $135^{\circ} 10'$ , of *t* to *t* =  $109^{\circ} 46'$ . Commonly maced. Colour white or yellowish, varying from transparent, to translucent only on the edges. Lustre pearly on the faces of cleavage, vitreous on the mostly uneven crystalline faces in other directions. Cleavage highly perfect parallel to T. Two analyses by Rose yielded,

Silica	58.59	60.28
Alumina	17.52	17.36
Lime	7.56	8.32
Water	14.48	12.52
Soda	1.78	0.00

Its comportment before the blowpipe resembles that of Heulandite; and in concentrated muriatic acid it is soluble, with the exception of a fine granular residue of silica. After ignition, however, it becomes insoluble.

## OBSERVATIONS.

Epistilbite accompanies the fine specimens of Skolezite from the Beruford in Iceland. It was distinguished by Dr G. Rose of Berlin, although, according to Levy (*Ann. of Phil.* third series, vol. i.), it is identical with the foregoing species, to which in some respects it bears

considerable analogy. Its superior hardness and specific gravity, and, above all, its distinctly different form, are however sufficient to separate it from stilbite and heulandite; and if farther aid were necessary to settle this point, the optical experiments of Sir D. Brewster (*Journal*, VI. 236) would be sufficient to do so—heulandite exhibiting the double system of polarized rings, while in epistilbite there is but one.

### BREWSTERITE.

Brewsteritic Kouphone Spar, *Haid.* Brewsterite, *Brooke*, *Edin. Phil. Jour.* VI. 112.

Sp. Gr. 2.1—2.2. H. = 5.0—5.5.

Hemi-prismatic. FIG. 99. Inclination of  $g$  to  $T = 93^\circ 40'$ ,  $d$  to  $d = 172^\circ$ . Colour white, inclining to yellow. Transparent or translucent. Lustre vitreous except on  $P$ , which is pearly. Cleavage highly perfect, parallel to  $P$ . Fracture uneven.

Before the blowpipe it loses its water, and becomes opaque, then froths and intumescs, but is difficultly fusible. It yields a skeleton of silica with salt of phosphorus, and contains, according to Connell, silica 53.66, alumina 17.49, strontia 8.32, baryta 6.75, lime 1.34, oxide of iron 0.29, water 12.58—*Edin. New Phil. Jour.* Jan. 1831. Thomson's analysis, *Royal Society Trans.* XI. 253, is incorrect.

#### OBSERVATIONS.

Brewsterite used to be considered a variety of stilbite, until distinguished and named by Brooke in honour of Sir David Brewster. It was first observed at Strontian in Argyleshire, where it generally occurs associated with calcareous spar; but has latterly also been met with coating the cavities of amygdaloidal rocks at the Giant's Causeway; in the lead mines of St Turpet, near Freiburg, in the Brisgau (*Brewster's Journal*, v. 186); in the department of the Isere in France; and in the Pyrenees.

### MESOLE.

Flabelliform Kouphone Spar, *Haid.* Brewster's *Journ.* VII. 18.

Sp. Gr. 2.35—2.4. H. = 3.5.

Prismatic. In implanted globules, which have a flat columnar or lamellar structure, radiating from the centre. Colour greyish white, sometimes yellow. Translucent, with a silky or pearly lustre. Cleavage perfect parallel to the broad face of the individual. Laminæ slightly elastic. Consists of,



	Sweden.	Faroe.
Silica	42.17	42.60
Alumina	27.00	28.00
Lime	9.00	11.43
Soda	10.19	5.63
Water	11.79 Hisinger.	12.70 Berzelius.

## OBSERVATIONS.

It occurs at Nalsole in the Faroe Islands, coating the cavities of basalt and amygdaloid, and associated with chabasie, apophyllite, stilbite, and others of the zeolite family; also in Disco Island, Greenland, in large individuals, which have a silvery lustre, a distinctly lamellar composition, and which bear much resemblance to crystallized spermaceti. Skagastrand in the north of Iceland, and Rostanga in Scania, Sweden, are likewise localities of Mesole. It is distinguished from mesotype by its perfect single cleavage and pearly lustre; from stilbite or heulandite by its superior specific gravity; and from apophyllite by its crest or fan-like aggregations, which never occur in that mineral. When associated with apophyllite or stilbite, it always forms the lowest stratum, immediately adjoining the basalt or amygdaloid, in the cavities of which it is deposited.

## APOPHYLLITE.

Pyramidal Kouphone Spar, *M.* Pyramidal Zeolite, *J.* Apophyllite, *P.* Ichthyophthalm, Fischaugenstein, Albin, *W.* Mesotype Epoutée, *H.*

Sp. Gr. 2.2—2.5. H. = 4.5—5.0.

Pyramidal. FIG. 100. Inclination of *P* to *P* = 104° 2', of *P* to *P'* = 121°. *Colour* white or greyish, rarely of a blue or rose-red tinge. *Transparent*, translucent, or opaque. *Lustre* vitreous, except on the faces *o*, which, both in the crystals, and as obtained by cleavage, are pearly. *Cleavage* highly perfect parallel to *o*. Consists of,

	Uton.	Greenland.	Oxhaverite.
Silica	52.13	51.86	50.76
Lime	24.71	25.20	22.39
Potash	5.27	5.14	4.18
Fluoric acid	0.82	0.00	traces.
Water	16.20 Berzelius.	16.04 Stromeyer.	17.36 Turner.

Its chemical formula corresponds to 5.26 potash, 25.40 lime, 53.18 silica, and 16.16 water; the small portion of fluoric acid observed by Berzelius is probably in combination with the lime.

It exfoliates before the blowpipe, intumesces, and ultimately fuses into a white vesicular globule. It melts easily with borax; and in nitric acid separates into flakes, becoming somewhat gelatinous and semi-transparent.

Its perfect cleavage, perpendicular to the axis of the prism, is highly characteristic.

#### OBSERVATIONS.

Mohs, in his first edition, separated such varieties of this substance as have a particularly lamellar structure, from common apophyllite, under the name of *Axifrangible Kouphone Spar*. There is however nothing, either in their external characters or chemical composition, to warrant such distinction. Though fig. 100 is the most common form which this beautiful mineral presents, particularly the Iceland varieties, it is nevertheless often met with, either devoid of the pyramidal faces P, thus forming a cube, or without o, and with such an enlargement of the lateral faces m, as to produce a four-sided prism with pyramidal terminations, like fig. 65. Sometimes the crystals are cylindrical, and being contracted at the extremities, exhibit a barrel-like shape. Interesting combinations have been observed in Greenland and the Faroe Islands; and my father's collection contains an extremely beautiful specimen, in large distinct transparent crystals, from the limestone quarry of Chappel near Raith, in Fifeshire. The peculiar pearly lustre of the crystallized varieties from Greenland, Iceland, the Faroe Islands, and Poonah in Hindostan, can never be mistaken; this is one of the most decided characters of the species, and has obtained for it the peculiar denomination of *Ichthyophthalmite*, or fish-eye stone, from the Greek *Ιχθυς*, a fish, and *ὀφθαλμος*, an eye. These varieties occur coating the cavities of amygdaloid, associated with calcedony, stilbite, chabasie, &c.; at Andreasberg it is found in silver veins, traversing grauwacke-slate; in the Bannat associated with wollastonite; and at the above-mentioned locality in Fifeshire, it appears to occupy the interior of fossil shells. Foliated apophyllite occurs, associated with magnetic iron, at Uton in Sweden (the original locality of this mineral), and along with analcime in the trap of the Seisser Alpe, Tyrol; at the former almost transparent, at the latter white and opaque. A pale-green coloured variety of this mineral was some years ago brought from the Oxahver Springs, near Husavick, in Iceland, and named by Sir D. Brewster *Oxahverite*; it is generally indistinctly crystallized, somewhat translucent, and disposed on wood fossilized by calcareous spar. (Brewster's Jour. vii. 115 and 118.) Werner's *Albin* rarely presents the terminal faces o; it is white and opaque, and occurs associated with Natrolite, at Aussig in Bohemia. The *Tesselite* of Brewster is that variety particularly accompanying chabasie and mesole, from Nalsole in the Faroe Islands, which presents, upon optical examination, a mosaic-like or tessellated structure.



## DAVYNE.

*Davytic Kouphone Spar, Haid. Davina, Monticelli. Brewster's Jour. VII. 326.*

Sp. Gr. 2.4. H. = 5.0—5.5.

Rhombohedral. FIG. 101. Inclination of  $r$  to  $r$  contiguous =  $154^{\circ} 46'$ , of  $r$  to  $M$  =  $115^{\circ} 53'$ . Colour white or yellowish. Transparent, translucent, or opake; the lustre inclining to opalescent in the first case, to pearly when opake, and the colour to grey when transparent, but to whitish when opake. Cleavage highly perfect parallel to  $M$ . Fracture conchoidal. Consists, according to Monticelli, of silica 42.91, alumina 33.28, lime 12.02, iron 1.25, water 7.43, loss 3.11. Treated with nitric acid it effervesces and forms a jelly; and alone before the blow-pipe fuses with effervescence into a white opake somewhat porous globule. Laminae exposed to the flame of a candle do not lose their transparency. With boracic acid on platina wire, it affords a limpid colourless globule, and with salt of phosphorus in proper proportions, yields a pearly bead, which appears milky and opake when hot, but becomes translucent on cooling.

## OBSERVATIONS.

This mineral was described by Monticelli and Covelli, in their *Prodro-mo della Mineralogia Vesuviana*, and named by these mineralogists in honour of our illustrious countryman Sir Humphry Davy. It occurs in the more ancient rocks of Vesuvius, accompanying garnet, mica, Wollastonite, &c. It may be distinguished from nepheline by the length of its crystals invariably exceeding their breadth, the reverse of which is the case in that mineral; its specific gravity is also much lower, and nepheline is not acted upon by acid as this is.

## HERSCHELLITE.

See Ann. of Phil. X. 361.

Sp. Gr. 2.11. H. = 4.5.

In six-sided prisms, whose lateral faces are streaked horizontally. Colour white. Translucent or opake. Fracture conchoidal. Cleavage easily obtained, parallel to the base of the prism. Contains, according to Wollaston, silica, alumina, and potash.

## OBSERVATIONS.

Herschellite occurs associated with Phillipsite in the cavities of trap, at Aci Reale, near Catania in Sicily. The individuals are sometimes isolated, but generally very closely aggregated, in a manner analogous to that which prehnite frequently presents.

## PETALITE.

Prismatic Petaline Spar, *M.* Prismatic Petalite, *J.* Petalit, *L.*

Sp. Gr. 2.4—2.5. H. = 6.0—6.5.

Prismatic. Occurs massive. *Colour* white or grey, with occasionally a pink tinge. *Translucent*. *Lustre* glistening or vitreous, inclining to pearly upon the perfect faces of cleavage. *Streak* white. *Cleavage* a prism of  $95^\circ$  nearly. *Fracture* imperfect conchoidal. Contains silica 79.21, alumina 17.22, lithia 5.76—Arfwedson. If gently heated, it emits a blue phosphorescent light, but when exposed to a high temperature on charcoal, it becomes glassy, semi-transparent, and white, although it melts difficultly, and then only on the edges; with borax it fuses slowly into a diaphanous glass.

## OBSERVATIONS.

Petalite has hitherto been met with only at the iron mine of Uton, an island about thirty-five miles S.S.E. of Stockholm, where it was first noticed by D'Andrada accompanying lepidolite, tourmaline, spodumene, and quartz. The pink tinge, which it sometimes presents, denotes a minute admixture of manganese. It was in the analysis of this mineral Arfwedson discovered Lithia, an alkali which has since been observed in so many other species, that Dr Turner proposes the following mode of testing its presence in the dry way: A minute portion reduced to powder, and made into paste with water, is exposed to the blowpipe. For a time it does not fuse, nor exhibit even a trace of redness; but by urging the heat, fusion at length occurs, and at that instant the flame assumes a red colour. If the mineral be melted *per se*, this momentary tinge appears faint; but if mixed with fluor spar its fusibility is greatly increased, and the red hue of the flame becomes more decided.

## NEPHELINE.

Rhombohedral Feldspar, *M.* Rhomboidal Felspar or Nepheline, *J.* Sommite, *P.* Nephelin of the Germans. Nefelina, Monticelli.

Sp. Gr. 2.5—2.6. H. = 6.0.

Rhombohedral. FIG. 44. Inclination of  $x$  to  $M = 134^\circ 3'$ .



*Colour* white. *Transparent* or translucent. *Lustre* vitreous. *Streak* white. *Cleavage* both parallel and perpendicular to the axis, indistinct. *Fracture* conchoidal. Consists of

		Somma.
Alumina	33.49	33.73
Silica	43.36	44.11
Soda	13.36	20.46
Potash	7.13 Gmelin.	0.00 Arfwedson.

Before the blowpipe, upon charcoal, its edges are rounded off, but it is otherwise infusible; with borax it forms slowly, and without effervescence, a transparent colourless glass. Fragments thrown into nitric acid assume a nebulous appearance, which suggested to Haüy the name of Nepheline, from νεφέλη, a cloud.

## OBSERVATIONS.

Nepheline is as yet almost peculiar to Monte Somma, the ancient crater of Vesuvius. It there occurs in large distinct six-sided prisms, occupying the cavities of ejected masses, and associated with idocrase, garnet, mica, and hornblende. It has been met with in the lava of Capo di Bove near Rome, and engaged in clinkstone at Katzenbuckel near Heidelberg. The collection of Sig. Monticelli at Naples contains some singularly splendid specimens of this substance.

## FELSPAR.

Prismatic Feldspar, *M.* and *J.* Felspar, Ice-Spar, *P.* Feldspath, Adular, Labrador, Eisspath, *W.* Feldstein, *Haus.* Feldspath, *H.*

Sp. Gr. 2.5—2.6. H. = 6.0.

Hemi-prismatic. FIG. 102. Inclination of  $x$  to the adjoining  $P = 129^\circ 8'$ , of  $T$  to  $T = 118^\circ 52'$ . Prevalent *colour* white, sometimes grey, green, or flesh-red. *Lustre* vitreous, inclining to pearly on the perfect faces of cleavage. Transparent, translucent, or almost opaque. *Cleavage* highly perfect, and easily obtained parallel to  $P$ , less so parallel to  $M$ , and often interrupted by conchoidal fracture. Consists of

	Green, Siberia.	Carlsbad.	Porcelain Earth.
Silica	62.83	64.50	46.0
Alumina	17.02	19.75	39.0
Lime	3.00	a trace	0.0
Potash	13.00	11.50	0.0
Oxide of iron	1.00	1.75	0.25
Water	0.00 Vauq.	0.75 Klap.	14.5 Klap.

Its chemical formula is expressive of 65·94 silica, 17·75 alumina, 16·31 potash ; which very closely corresponds with the analysis of Murchisonite, as given by R. Phillips. Before the blowpipe, upon charcoal, it becomes glassy, semi-transparent, and white, but fuses only on the edges. With borax it dissolves slowly into a clear globule, and is not acted upon by acids.

## OBSERVATIONS.

This and the four following species used to be included under one head, but the accurate researches of Dr Gustav Rose of Berlin precludes the possibility of longer classifying them together, although their chemical composition is identical.—The following characteristics may be useful. In common felspar the two principal cleavages intersect each other at right angles, while in the other species they are placed obliquely. Anorthite and labradorite are soluble in concentrated muriatic acid, which is not the case with the others. Pericline occurs always, albite seldom otherwise than, macled ; anorthite never. Few minerals vary so much in appearance, or present more numerous and complicated crystalline forms. Being also with quartz and mica a component part of granite and gneiss, it is of frequent occurrence in countries abounding with primitive rocks ; and on its colour in general depends that of all granites—of which it constitutes the principal ingredient. Its most simple crystalline form is an oblique four-sided prism, closely resembling the regular rhomb, and consisting of the faces *x* and *T* only ; this is met with in individuals of considerable size at St Gothard, accompanying amianthus, and superficially coated with chlorite. Fig. 102 represents the usual form of Vesuvian ice-spar ; it is one of the simplest varieties, and affords a diagram to which others may be referred.

The fine transparent crystals of Adularia, again, are extremely complicated, consisting of two, three, or four individuals, placed either in parallel position, or obliquely to one another. These are often of a large size, are found in the highest districts of Savoy, and derive their name from Adula, one of the peaks of St Gothard. If very splendid, with a pearly lustre, and exhibiting, especially when cut *en cabachon*, a bluish chatoyant reflection of light, this variety is termed *Moonstone* ; magnificent specimens of which are brought from Ceylon, imbedded in granite. The *Sunstone* is the same, having exceedingly minute scales of mica interspersed throughout its mass, which, being disposed in parallel position, reflect a pinchbeck-brown tint. In these, as well as the Norwegian Labrador, as it is called, from Frederickswarn, this opalescent appearance is only in one direction, namely, in that which bevels the edge between *T* and *T* somewhat obliquely. The variety from the latter locality is a grey felspar totally distinct from the species Labrador which follows, but possessing, like it, some very beautiful hues ; it occurs in large masses, but fractures with too great facility to admit of being employed for ornamental purposes.



The coarser kinds of felspar are also frequently macled, presenting some of the most remarkable hemitrope forms that occur in the mineral kingdom. At Carlsbad and Elbogen in Bohemia, twin crystals occur, exhibiting the union of two individuals which have been turned round to the extent of  $180^\circ$ , and attached to each other laterally. According to their points of junction, these are denominated *rights* and *lefts*, for in whatever position one of them is placed, its faces are never parallel or homologous to those of the other; figs. 103 and 104, however, will afford a better idea of these remarkable forms than any description that can be given of them. At Carlsbad they occur from two to four inches in length, the rapid decomposition of the surrounding granite strewing the fields with them in vast quantities. They, as well as the varieties from Ekatherineburg in Siberia, and Warmbrunn in Silesia, are opaque, have an earthy-brown colour, and are extremely coarse and rough exteriorly. The Land's End granite is also studded with similarly formed crystals, though on a smaller scale; and, what is remarkable, pseudo-crystals of tin have been found in Cornwall assuming precisely similar macles. Large well-defined opaque crystals are brought from Elba, and Arendal in Norway. The twins from Baveno in Piedmont, and La Clayette in Auvergne, are well known; as are the beautiful varieties accompanying beryl and topaz in the Mourne Mountains of Ireland.

Common felspar likewise includes, the green *Amazon stone* from the Uralian Mountains, where it has occasionally been met with crystallized; the pearl-grey, translucent, and resplendent variety from Greenland; the yellowish grey, somewhat transparent kind, from Dawlish and Arran, named *Murchisonite* by Levy; and the *pegmatite* or *graphic-granite* of Hutton, which is merely a reddish felspar, mixed with long parallel crystals of quartz, whose transverse angular sections bear some resemblance to certain kinds of writing. The *Leelite* of Dr Clarke, or the *Hellefinta* of the Swedes, is found compact and massive, of a deep flesh-red colour, and having a peculiarly waxy texture, at Gryphyttan in Sweden; while the *Variolite* from the Drac river in France, which is usually of a dark-green colour, with orbicular specks of a lighter tinge, has also been placed under this head.

*Glassy felspar* applies particularly to such imbedded crystals as present considerable degrees of transparency, and which are of most frequent occurrence in trachytic and other volcanic rocks. The trachyte of the Drachenfels on the Rhine, of which the cathedral of Cologne is built, presents this variety in great abundance, as do the lavas which devastated a portion of the island of Ischia in 1302. *Ice-spar*, again, occurs in white transparent crystals implanted in the drusy cavities of rocks anciently ejected by Vesuvius, and may be picked up in profusion on that portion of the mountain called the Fossa Grande.

Porcelain earth, or *kaolin* of the Chinese, the principal ingredient of the different kinds of china, is produced by the decomposition of granitic rocks, as at Carclaise and Cligga in Cornwall, at Aue near Schneeberg

in Saxony, on the island of Bornholm in the Baltic, and at Hafnerzell near Passau in Bavaria. The twin crystals from Carlsbad are frequently disintegrated, and present individuals of these forms which consist either entirely of porcelain earth, or still enclose a small portion of compact felspar. Pure varieties of felspar are employed in certain proportions along with this and quartz, in the composition of porcelain, as well as in forming the enamel with which it is afterwards glazed. Porcelain used to be brought from Japan and China; the art itself being unknown in the west until discovered by a German named Botticher, who made his first porcelain vessels at Dresden in the year 1706. These were principally of a brown and red colour, and in beauty and symmetry of form, if we may judge from what are still preserved in the Japan palace at Dresden, have not been surpassed in modern times. The celebrated manufactory of Meissen was founded in 1710; and vast quantities of this beautiful ware are now also made at the government establishments of Sevres near Paris, Copenhagen, Berlin, Vienna, Madrid, and Munich. Worcester, too, is not inferior to any of these in the beauty of its china, though, from the fineness of our British stoneware, porcelain is less used in this country than on the continent. Much common felspar is sent from Aberdeenshire, and compact felspar from Caernarvonshire, to the Staffordshire potteries.

#### PERICLINE.

Heterotomous Feldspar, *M.* Periklin, *Breithaupt.*

Sp. Gr. 2.54—2.56. H. = 6.0.

Tetarto-prismatic. FIG. 105. Twin crystals, in which the faces T are shorter than in the figure. *Cleavage* perfect parallel to P and T; more so to T than to M, the reverse of which is the case in albite. The Zöblitz variety contains, according to Professor Gmelin, silica 67.91, alumina 18.93, soda 9.99, potash 2.41, lime 0.15, oxide of iron 0.48. Pericline is more generally opaque than other species of felspar.

#### OBSERVATIONS.

It occurs in large distinct crystals at St Gothard in Switzerland, in the Pfundersthal and Schmiernerthal in the Tyrol, upon the Sau Alpe in Carinthia, at Zöblitz in Bohemia, and other places. It much resembles albite in form, and was distinguished from that species by Breithaupt, principally in consequence of its inferior specific gravity.



## ALBITE.

Tetarto-prismatic Feldspar, *M.* Cleavlandite, *P.* and *Levy*.

Sp. Gr. 2·6—2·68. H. = 6·0.

Tetarto-prismatic. FIG. 105. Generally in flat twin crystals, of which the face *M* is greatly enlarged. Inclination of *M* to *P* =  $93^{\circ} 50'$ , of *P* to *P* the re-entering angle =  $186^{\circ} 40'$ . *Colour* commonly white, sometimes grey, green, or brown, varying from transparent to opaque. *Lustre* pearly upon cleavage planes, vitreous in other directions. *Cleavage* perfect parallel to *M* and *P*, less so to *T*. Composition same as felspar, with the exception of soda instead of potash.

	Finbo.	Arendal.	Chesterfield.
Silica	70·48	68·84	70·68
Alumina	18·45	20·53	19·80
Soda	10·50	9·12	9·06
Lime	0·55	Eggertz. a trace, Rose.	0·23 Strom.

Its chemical formula is expressive of silica 69·78, alumina 18·79, and soda 11·43. Its comportment before the blowpipe resembles that of felspar.

## OBSERVATIONS.

Albite occurs in large transparent colourless crystals, with pearl spar, in the Tyrol; and at St Gothard in white translucent twins, having a brilliant lustre; at Arendal with epidote and garnet; with eudyalite and hornblende in Greenland; and with tourmaline at Massachusetts; also in Siberia, Norway, Sweden, Bohemia, Oisans in Dauphiné, and elsewhere on the continent. In the granite of the Mourne Mountains it is associated with felspar, from which however it may be distinguished by superior whiteness and translucency. Indeed these are frequently found in the same granite, as in that of Pompey's Pillar, and the block on which the statue of Peter the Great in St Petersburg is placed, the albite presenting a greenish-white colour, while the felspar is flesh red. The crystals from Baveno are often extremely curious in this particular, the albite being disposed in parallel position upon the faces of the felspar, from which its greater whiteness distinguishes it. Albite, more frequently than felspar, is one of the constituents of syenite and greenstone, as in the rocks around Edinburgh. Romé de l'Isle first distinguished it as a particular species under the name of white schorl; but it is to Dr G. Rose that mineralogists are indebted for their more accurate knowledge of its properties. (Gilbert's Annalen, Feb. 1823.)

## ANORTHITE.

Anorthotomous Feldspar, M. Christianite, *Monticelli*. Anorthite, *Rose*.

Sp. Gr. 2.65—2.78. H. = 6.0.

Tetarto-prismatic. FIG. 102. Inclination of *l* to *M* =  $122^{\circ} 2'$ , of *T* to *l* =  $120^{\circ} 30'$ , of *T* to *M* =  $117^{\circ} 28'$ , of *P* to *M* =  $94^{\circ} 12'$ . Colour white. Transparent or translucent. Lustre vitreous, inclining to pearly on planes of cleavage. Streak white. Cleavage perfect parallel to *P* and *M*. Fracture conchoidal. Consists of silica 44.49, alumina 34.46, oxide of iron 0.74, lime 15.68, magnesia 5.26—G. Rose.

Before the blowpipe its comportment nearly resembles the two preceding species, only with soda it does not yield a clear glass. It is entirely decomposed in concentrated muriatic acid.

## OBSERVATIONS.

Monticelli, in his *Mineralogia Vesuviana*, has described this mineral under the name of Christianite, in compliment to the crown prince of Denmark, though it is precisely the same previously distinguished by Dr Gustav Rose, and mentioned in Gilbert's *Annalen der Physik* for 1823. Its principal locality is Vesuvius, or rather Monte Somma, the ancient crater of that mountain; for the productions of the volcano, at the present day, are comparatively of little moment to the collector, who, when in search of its numerous fine minerals, never ascends the cone, but bends his steps at once to the water-worn ravines of Monte Somma. These consist principally of tuff, scoria, and small portions of pumice, with numerous imbedded masses of limestone, mica, hornblende, and minerals. As the lighter portions of the tuff are cleared away, and the abrupt banks brought down by the rain, these imbedded masses are laid bare, and among them a variety of beautiful minerals may be collected. The anorthite generally occupies the cavities of chloritic masses, and is accompanied with ice-spar, augite, mica, and idocrase.

The island of Procida near Naples, and Columbia, are mentioned as other localities of anorthite. As its angles are not always to be obtained with facility, the following distinguishing characters are valuable. From topaz it is easily known by inferior hardness and specific gravity; from chrysolite by lower degrees of specific gravity. Nitric acid has no effect on chondrodite, while anorthite is partly dissolved in it; the former too is always yellow or brownish-yellow, the latter is invariably white. Its infusibility before the blowpipe serves to distinguish it from all the zeolites, as well as from nepheline and leucite.



## LABRADORITE.

Polychromatic Feldspar, *M*.Sp. Gr. 2·69—2·76.  $H. = 6·0$ .

Tetarto-prismatic. Imperfectly formed crystals, having the general character of albite, some of them simple, others macled. *Colour* grey, brown, or greenish. Translucent or opaque. *Lustre* pearly on the perfect faces of cleavage. The remarkable opalescent and iridescent tints appear brightest upon the face *M*, though they are also observable on *P*; of these the most frequent are blue and green, also yellow, red, and pearl-grey; different hues appearing in the same specimen. *Cleavage* perfect parallel to *P*, less so to *M*. Klaproth found, in the variety from Labrador, silica 55·75, alumina 26·50, lime 11·00, soda 4·00, oxide of iron 1·25, water 0·50. Its comportment before the blowpipe resembles that of felspar and albite; but it is entirely dissolved in heated muriatic acid, which does not attack either of the others.

## OBSERVATIONS.

This mineral, often so remarkable for its brilliant iridescence, is distinct from the opalescent felspar of Fredericksvarn in Norway, in which the opalescence takes place in the direction of a plane intersecting the two faces *T* and *T'*; while in this species it is parallel to *P* and *M*. Rough indistinctly formed crystals of considerable size were brought by Gièsécke from Greenland; but the beautiful iridescent slabs to which the name of their locality is applied, occur in the island of St Paul, on the coast of Labrador, associated with hornblende, hyperstene, and magnetic iron-ore. As it receives a good polish, it is valued on account of its fine colours, being formed into snuff-boxes, clasps, and other ornaments. For observations on its optical properties, see Sir D. Brewster's elaborate paper in the Royal Soc. Trans. Edin. xi. 322.

## SCAPOLITE.

Pyramidal Feldspar, *M*. Meionite, Prismato-pyramidal Felspar, *J*. Dypyre, Scapolite, *P*. Schmelzstein, Skapolith, *W*. Tetraklasit, *Haus*. Wernerite, Mejonite, *L*. Wernérite; Paranthine, Dypyre, *H*.

Sp. Gr. 2·5—2·8.  $H. = 5·0—5·5$ .

Pyramidal FIG. 106. Inclination of *l* to *l* =  $136^{\circ} 7'$ , of *l* to *s* =  $121^{\circ} 54'$ . *Colour* various shades of white, grey, or green; red hues arise from impurities. *Lustre* vitreous, inclining to

resinous or pearly upon *s.* Varies from transparent to opaque. *Cleavage* parallel to *M* and *s.* *Fracture* imperfect conchoidal. Contains

	<i>Meionite.</i>	<i>Scapolite.</i>	<i>Wernerite.</i>	<i>Dypyr.</i>
Silica	40.53	43.83	50.25	60.0
Alumina	32.73	35.43	30.00	24.0
Lime	24.25	18.96	10.45	10.0
Potash and soda	1.82	0.00	2.00	0.0
Protoxide of iron	0.18	0.00	4.45	0.0
Water	0.00	1.03	2.85	2.0
	Stromeyer.	Nordenskiöld.	John.	Vauquelin.

When strongly heated before the blowpipe it fuses into a vesicular glass, and intumesces considerably, then assumes the appearance of ice, and does not melt any longer. It is soluble in borax with effervescence, and fuses with it into a transparent globule.

## OBSERVATIONS.

The varieties of this species differ so materially in external aspect, that the older mineralogists, unacquainted with their true physical properties, described most of them as distinct substances. We shall continue their trivial names, and notice each separately. *Meionite* includes the pure, transparent, and in general small but perfectly crystallized varieties, which are met with only among the debris of Monte Somma.

*Scapolite*, again, occurs in primitive mountains, in beds of iron ore at Arendal in Norway, and in the mining district of Wermeland in Sweden, presenting large and beautiful crystals in the parish of Pargas in Finland, at Akudlek in Greenland, &c. It never occurs transparent, but generally possesses a greenish colour, either pale and somewhat translucent; or dark, and then the crystals are nearly opaque. Some of its varieties are tinged red, probably from a slight admixture of iron. *Scapolite* is found accompanying hornblende and garnet at Arendal, in long slender crystals, which being imbedded in calcareous spar, admit of transport with the greatest safety, and may be cleared from their calcareous covering by immersion in dilute muriatic acid. *Wernerite* occurs at the same locality, generally in short thick crystals, which have a granular composition, and present for the most part darker shades of colour; beautiful specimens are also brought from Greenland. *Paranthine*, including the more compact varieties, possesses pure white and pale blue colours, and is met with in the limestone quarries of Gulsjo and Malsjo in Wermeland. *Dypyr* occurs in small greyish or reddish-white indistinct prisms, very much decomposed, in the torrent of Mauléon in the western Pyrenees; it is a rare variety, and is usually imbedded in slate.



## EDINGTONITE.

Hemi-pyramidal Feldspar, *Haid.* Brewster's Jour. III. 316.

Sp. Gr. 2·7—2·75. H. = 4·0—4·5.

FIG. 107. Inclination of  $n$  to  $n$  over the summit =  $129^{\circ} 8'$ , of P to P over  $n$  and  $n = 92^{\circ} 41'$ . Colour greyish-white. Translucent. Lustre vitreous. Streak white. Brittle. Cleavage perfect parallel to  $m$ . Before the blowpipe it fuses into a colourless mass, though a pretty strong heat is necessary for that purpose. It yields water when exposed to a high temperature, and becomes at same time opake and white. It contains, according to Dr Turner, silica 35·09, alumina 27·69, lime 12·68, water 13·32, and, as he supposes, about ten or eleven per cent. of some alkali, the nature of which, from the minute quantity afforded for analysis, he was unable to ascertain.

## OBSERVATIONS.

This mineral exhibits the extremely rare instance of a hemi-pyramidal form. It was remarked by Haidinger on a specimen of Thomsonite from Dumbartonshire, in the collection of Mr Edington of Glasgow, in small but extremely distinct crystals. From its great rarity, a satisfactory analysis has not yet been made, but its peculiar crystalline form, specific gravity, and hardness, are sufficiently characteristic.

## LATROBITE.

Latrobite, *Brooke.* Diploite, *Breithaupt.* Gmelin, Brewster's Journal, II. 287.

Sp. Gr. 2·7—2·8. H. = 5·0—6·5.

Occurs crystallized and massive, of a pale rose-red colour. Opake. Lustre vitreous. Cleavage in three directions, intersecting each other at angles of  $98^{\circ} 30'$ ,  $91^{\circ}$ , and  $93^{\circ} 30'$ . Two analyses by Gmelin yielded

Silica	44·65	41·78
Alumina	36·81	32·83
Lime	8·29	9·79
Oxide of manganese	3·16	5·76
Potash	6·58	6·57
Water	2·04	2·04

a little magnesia.

Before the blowpipe, in the platina forceps, it fuses, intumesces into a white enamel, and with borax yields a globule which is

pale amethyst red in the oxidating flame, and colourless in the reducing one. With salt of phosphorus it fuses into a clear glass, containing a skeleton of silica.

Its only known locality is Amitok Island, near the coast of Labrador, whence it was brought by the Rev. C. J. Latrobe, who found it associated with felspar, mica, and calcareous spar.

### NUTTALITE.

Brooke. Ann. of Phil. No. XLI. 366.

Sp. Gr. 2·7—2·8. Scratched by the knife.

In rectangular four-sided prisms, of a grey colour, imbedded in calcareous spar. Has considerable resemblance to scapolite, but is softer, and more vitreous in the fracture; it also possesses a play of light on the faces of the prism, similar to that of eliolite. *Colour* white, in some parts yellowish, in others bluish or green; the yellow portions transparent, the blue nearly opaque. *Streak* white. *Lustre* vitreous. Contains silica 37·81, alumina 25·10, lime 18·33, protoxide of iron 7·89, potash 7·30, water 1·50—Thomson.

This mineral is noticed by Dr Meade in Silliman's Journal, VII. 52, under the name of Eliolite. Its locality is Bolton, Massachusetts; it was brought to this country some years ago by Mr Nuttall, and first discriminated by Brooke.

### ELAOLITE.

Fettstein, W. Pierre Grasse, Levy.

Sp. Gr. 2·54—2·62. H. = 5·5—6·0.

Occurs massive. *Colour* dark green, bluish-grey, or brick-red. Translucent. *Lustre* resinous. Frequently opalescent when cut. *Cleavage* both parallel and perpendicular to the axis of a four-sided prism. *Fracture* conchoidal. Consists of

Silica	46·50	44·19
Alumina	30·25	34·42
Lime	0·75	0·52
Potash	18·00	4·73
Soda	0·00	16·88
Oxide of iron	1·00	1·36
Water	2·00 Klaproth.	0·00 Gmelin.

It gelatinizes freely with acids when reduced to powder, and before the blowpipe fuses into a white enamel.



## OBSERVATIONS.

The name is derived from the Greek *ελαιον* oil, and *λιθος* a stone, in allusion to its peculiar resinous or oily-like lustre. It occurs only in Norway, imbedded in the zircon-syenite of Laurvig, Stavern, and Fredericks-warn. The pale blue has a slight opalescence, like cat's eye, whence it is occasionally employed for ornamental purposes. Leonhard, influenced by the similarity of their chemical composition, has united this substance with nepheline; and certainly the variety of the latter from Katzenbuckel somewhat resembles elalite.

## AUGITE.

Paratomous Augite Spar, *M.* Pyramido-prismatic Augite, *J.* Augite, Pyroxene, Diopside, Sahlite, Pyrgom, Coccolite, Fassait, *P.* Kokkolit, Baikalit, Omphazit, *W.* Pentaklasit, *Haus.* Pyroxene, Malacolith, *H.*

Sp. Gr. 3.2—3.5. H. = 5.0—6.0.

FIG. 108. Inclination of *s* to *s* = 120°, of *M* to *M* over *r* = 87° 5', of *r* to the terminal edge between *s* and *s* = 106° 6'. Varies much in colour from green or grey to brown and black. Sometimes transparent or translucent, generally opaque. *Streak* white or grey, according to the colour. *Lustre* vitreous, inclining to resinous. *Cleavage* perfect, parallel to *r*. *Fracture* conchoidal, uneven. *Brittle*. Contains,

	White.	Green.	Black.
Silica	54.83	54.08	53.36
Lime	24.76	23.47	22.19
Magnesia	18.55	11.49	4.99
Alumina	0.28	0.00	0.00
Protox. of iron	0.99	10.02	17.38
Ox. of manganese	0.00	Bonsdorf. 0.61	Rose. 0.09

It may be considered as a bi-silicate of lime and magnesia, in which part of the bases are replaced by protoxide of iron, part of the silica sometimes by alumina, which, in the conchoidal augite from Sicily, amounts to 16.5. It fuses before the blowpipe, emits a few bubbles, and finally yields a glassy globule more or less tinged with iron. It is readily dissolved in borax.

## OBSERVATIONS.

This species unites numerous varieties, which the older mineralogists described as distinct minerals. *Augite* comprehends almost exclusively such as are opaque and dark-green or black. It is a very common product

of volcanic rocks: in some of the scorïæ from Etna, at the Monti Rossi, for instance, beautiful crystals similar to the above figure are met with in great abundance; and among the ejected masses of Vesuvius, at Stromboli, as well as in the vicinity of many extinct volcanoes in Auvergne and elsewhere, they are equally frequent. The largest known crystals, from one to two inches in length, occur imbedded in basalt near Aussig and Toplitz in Bohemia; but it is also met with in that rock at many other places on the continent. It is likewise occasionally found in primitive rocks, as in Greenland and at Arendal, where it passes sometimes by insensible shades into coccolite, and is accompanied by garnet, mica, &c. Small but extremely perfect and highly brilliant transparent crystals, presenting various brown, yellow, and green tints, are found along with idocrase, nepheline, and mica, at Vesuvius. When decomposed, it forms those peculiar earthy masses denominated *crystallized green earth*, which are found, in beds of trap tuff, at Pozzo in the Fassa valley, and in Transylvania. *Diopside* includes dark green, greenish-white, and semi-transparent crystals; it occurs in veins traversing serpentine, both in translucent distinct crystals, and in compressed diverging prisms, at Ala in Piedmont (hence its name of *alalite*), associated with hyacinth-red garnets and crystallized green talc; and, of late years, also in large individuals and crystalline masses, sometimes of a fine pistachio-green colour, on the Rothenkopf in the Zillerthal, Tyrol. Some of these last, when cut and polished, form handsome ornamental stones, affording various colours between the emerald and yellow topaz. *Baikalite* (so called from its locality, the mouth of the Sljumanka river, which falls into lake Baikal) and *pyrgom* or *fassaite* apply principally to dingy-green coloured crystalline varieties. *Coccolite* possesses paler shades of green, and consists of small distinct granular particles, which may be easily separated, even by the finger. The colours of the massive variety termed *sahlite* are still paler green, or inclining to grey, and it is faintly translucent on the edges; sometimes, however, it is black and opaque. Both coccolite and sahlite are found in veins traversing primitive rocks, the former principally at Arendal in Norway, the latter at Sahla, and elsewhere both in Sweden and Norway. *Omphazite* is compact, foliated, and leek-green; it is found accompanying granular garnet at the Sau Alpe in Carinthia, and near Hof in Bayreuth, along with that variety of the following species named Smaragdite, to which it bears considerable analogy.

Several varieties of this species have been obtained by fusion. Minute black crystals are not unfrequent among the iron slags of Sweden; while perfect crystals of a white colour may be obtained by mixing silica, lime, and magnesia in the proportions indicated by analysis, and exposing the mixture in a charcoal crucible to the heat of a porcelain furnace. This was observed by Messrs Mitscherlich and Berthier. Some varieties, if melted and allowed to cool slowly, crystallize again, and assume an appearance little different from what they originally presented.



## BABINGTONITE.

Axotomous Augite Spar, *M.* Levy in Ann. Phil. April 1824.

Sp. Gr. 3.4—3.5. H. = 5.5—6.0.

Tetarto-prismatic. FIG. 109. Inclination of *P* to *m* =  $92^{\circ} 34'$ , of *m* to *h* =  $137^{\circ} 5'$ , of *m* to *g* =  $132^{\circ} 15'$ , of *m* to *t* =  $112^{\circ} 30'$ ; sometimes the faces marked *m* are wanting. *Colour* dark-greenish black; the splinters faintly translucent, and presenting a green colour perpendicular to *P*, a brown tinge parallel to it. *Lustre* vitreous. Surface brilliant. *Cleavage* perfect parallel to *P*, less so to *t*. *Fracture* imperfect conchoidal.

Before the blowpipe it fuses on the surface into a black enamel, and with borax gives a transparent amethystine coloured globule, which in the reducing flame becomes bluish-green.

## OBSERVATIONS.

Babingtonite resembles certain dark-coloured varieties of augite, from which it was first distinguished by Levy. According to Children, it is composed of silica, iron, manganese, and lime, with a trace of titanium. It occurs in very distinct crystals at Arendal in Norway, associated with epidote and massive garnet; and in the Shetland Isles imbedded in white quartz. It was named in honour of Dr Babington.

## HORNBLLENDE.

Hemi-prismatic Augite Spar, *M.* Axotomous Schiller Spar or Green Diallage, Hemi-prismatic Augite, *J.* Hornblende, Smaragdite, Pargasite, Tremolite, Actynolite, Asbestos, *P.* Strahlstein, Tremolith, Karinthin, Kalamit, Amiant, *W.* Grammatit, Byssolith, *Haus.* Amphibole, Actinote, Diallage Verte, Asbeste, *H.*

Sp. Gr. 2.8—3.2. H = 5.0—6.0.

Hemi-prismatic. FIG. 110. Inclination of *s* to *s* =  $148^{\circ} 39'$ , of *M* to *M* =  $124^{\circ} 30'$ , of the edge between *s* and *s* to that between *M* and *M* =  $104^{\circ} 58'$ . *Colour* various shades of green most prevalent, though an uninterrupted series may be traced from the perfectly white to the pure black varieties. Sometimes nearly transparent, generally opaque. *Lustre* vitreous, inclining to pearly upon the faces of cleavage in the pale-coloured varieties. *Streak* greyish-white or brown. *Cleavage* highly perfect parallel to *M*; less so in the direction of a plane truncating the lateral edge. *Fracture* uneven. Brittle; when massive, fre-

quently tough and difficultly frangible. From M. Bonsdorff's researches, Edin. Phil. Jour. vi. 17, this species appears to consist of the following ingredients:—

	<i>White, Gulsjo.</i>	<i>Green Pargasite.</i>	<i>Black, Pargas.</i>
Silica	60·31	46·26	45·69
Magnesia	24·23	19·03	18·79
Lime	13·66	13·96	13·85
Alumina	0·26	11·48	12·18
Protoxide of iron	0·15	3·43	7·32
Protoxide of manganese	0·00	0·36	0·22
Fluoric acid	0·94	1·60	1·50
Water & foreign matter	0·10	1·04	0·00

Hornblende is therefore a bisilicate of lime and magnesia, in which the silica is in some instances partly replaced by alumina. The black varieties invariably contain more iron than those which are lighter in colour, as may be ascertained by exposure to the blowpipe, or bringing them in contact with the magnetic needle; and, in general, the whole species contains less lime than augite. Hornblende also is less fusible; and neither *per se* nor with borax does it melt so readily; its fusibility moreover depends greatly on composition. It affords with borax a transparent globule, and with salt of phosphorus a glass which becomes opaline on cooling. It is not electric when heated, like tourmaline, and may be distinguished from schorl, both by its measurements and its comportment before the blowpipe.

#### OBSERVATIONS.

This species comprehends Hornblende, Actinolite, Tremolite, and Asbestos. No two minerals present more apparent disparity than its numerous varieties; and few in the whole system are more universally diffused. *Hornblende* is distinguished chiefly by its black or green colours, and comprises three sub-species, *basaltic hornblende*, *common hornblende*, and *hornblende slate*. The first of these includes imbedded and perfectly cleavable black crystals, which are found, like those of augite, and frequently along with them, in basaltic and amygdaloidal rocks; it appears in six-sided prisms, variously terminated by three or four planes, as represented in Fig. 111; the two extremities being generally dissimilar, and in that case forming macled or twin crystals; Aussig and Töplitz in Bohemia are its most celebrated localities, though it occurs also in the trap rocks of this country. Common hornblende refers to such as possess less distinct cleavages; it includes all implanted crystals, and massive, granular, or columnar varieties,—*carinthine*, from the Sau Alpe in Carinthia; *hedenbergite*, from Tunaberg in Sweden; and several others. It is met with



in the repositories of magnetic iron at Arendal, and other mining districts of Norway and Sweden; imbedded in limestone, and of a green colour, at Pargas in Finland, whence the name of *pargasite*; and in crystals, occupying the drusy cavities of Vesuvian minerals, where, though small, they are generally distinct, and possess high degrees of lustre. Gièsécke found it in Greenland of an asparagus green colour, and translucent, exhibiting occasionally a fine blue opalescence like Labradorite. Hornblende-slate forms beds in gneiss, mica schiste, and other primitive rocks; it possesses a slaty fracture, and comprehends such compound varieties as consist of confusedly aggregated crystalline particles. Massive hornblende only differs from the last in having no distinct fracture, and being commonly tough and difficult to break; it is met with on the Sau Alpe in Carinthia, and in several places in Saxony. Hornblende is an essential ingredient of syenite and greenstone; and occurs frequently in granite, gneiss, and other mountain rocks.

*Actinolite* comprehends the green acicularly-crystallized varieties from Salzburg, and Greiner in the Zillerthal, and has been subdivided into *glassy*, *asbestiform*, and *granular*. Glassy actinolite includes crystals and columnar masses, with a vitreous or pearly lustre. Asbestiform refers to capillary crystals of a green or greenish-grey colour, disposed in wedge-shaped masses or in radii, sometimes promiscuously aggregated. Granular actinolite includes such grass-green varieties as have a granular composition. *Tremolite*, similarly divided into sub-species, differs from the preceding principally in its pale-green, grey, or white colours. Common tremolite occurs both crystallized, and in masses which have a columnar composition and possess low degrees of transparency. When clear, it is called glassy tremolite; and occurs in acicular individuals at St Gothard, at Sebes in Transylvania, &c. imbedded in granular limestone or dolomite; fibrous radiated specimens, having a white silky appearance, occur in Glen Tilt, in primary limestone. Asbestiform tremolite forms masses of thin capillary crystals in Switzerland, the Tyrol, the Bannat, and other places; some beautiful specimens are met with at St Gothard in dark-green groups, which much resemble some varieties of green carbonate of copper; also fibrous, snow white, and translucent, in a bed of limestone connected with gneiss, at Gulsjo in Sweden. *Calamite* is a soft, asparagus-green, translucent variety, from Normarken in Sweden, where it occurs in imbedded prisms in serpentine. The term *Asbestos* rather expresses the state of aggregation of several, than the substance of a distinct mineral; it has been divided into *amianthus* or mountain flax, which consists of highly delicate fibres, often thinner than a hair, longitudinally cohering, easily separated, and more or less flexible and elastic; into *common asbestos*, relating to coarser and more compact varieties, which yield splintery fragments, and may be distinguished from amianthus by their want of flexibility; into *rock-cork*, in which the particles present a loose felt-like texture, no longer recognizable or capable of separation, and which not only swims on water, but is sectile, almost like com-

mon cork ; into *mountain-leather*, which occurs in flexible flat pieces, having an interwoven fibrous structure, and much the aspect of leather ; and into *rock-wood* or *ligneous asbestos*, whose composition, more close than the preceding, resembles membranes, and assumes the general appearance of wood. The latter breaks in long masses parallel to the fibres, which are sometimes curved, and are often as hard and compact as petrified wood. Amianthus occurs in serpentine in Savoy, Saltzburg, the Tyrol, and Corsica, where it is found in such profusion that Dolomieu used it instead of tow for packing his minerals. Rock-cork is met with in Saxony, Sweden, Portsoy, and Leadhills ; mountain-leather principally at Leadhills, and Strontian in Argyleshire ; and rock-wood at Schneeberg, near Sterzing in the Tyrol. The *Amianthoide* of Haüy, from Oisans in France, seems to be a variety of amianthus, distinguished by a degree of elasticity in its capillary fibres. Green diallage or *smaragdite*, Haidinger found in some cases to consist of laminæ of this mineral, alternating with laminæ of augite, both frequently of bright green colours, and forming a curious mixture in some of the rocks of Corsica, Monte Rosa, and the Bacher ; his valuable researches on the subject, exhibiting the impropriety of uniting this variety with diallage, as assumed by Haüy, are embodied in a paper in the tenth volume of the Edin. Royal Society's Transactions. Greatly as black crystallized hornblende and white silky asbestos differ in aspect, specimens exist in which the passage of the one into the other is distinctly visible ; my father's collection contains one of this description from Taberg in Wermeland, Sweden. The Corsican variety, from its colour, hardness, and the fine polish it assumes, is used for ornamental purposes, being known to Italian lapidaries under the name of *Verde de Corsica duro*.

Dr Thomson, who has lately made a series of examinations on the composition of these minerals, gives the following results :—

	White Amianthus, Sardinia.	Rock Wood, Tyrol.	Mountain Leather, Strontian.	Mountain Cork, Piemont.
Silica	55.91	54.92	57.65	57.75
Magnesia	27.07	26.08	2.06	10.85
Lime	14.63	...	10.00	14.05
Alumina	1.82	1.64	9.50	1.95
Protox. of iron	6.52	12.60	5.80	18.90
Water	0.00	5.28	21.70	...
Protox. of mangan.	...	...	...	1.85

The chemical constituents of these vary more than we should have expected. Rock-wood, it seems, is the only variety of hornblende devoid of lime ; while the proportion of water in mountain-leather is unusually large ; when heated to redness this last alters its appearance, and no longer resembles leather.

Though a general similarity exists between diallage, hyperstene, and basaltic hornblende, their cleavage cannot be mistaken. Diallage has only one distinct cleavage ; hyperstene three, of which two are silvery,



and one copper-like ; while basaltic hornblende has only two, and moreover by transmitted light displays a deep-red colour.

From asbestos the ancients used to manufacture a kind of coarse cloth, which, on account of its unflammable nature, was employed in wrapping round the bodies of their dead, when placed on the funeral pile. But though this cloth of asbestos, when soiled, is restored to its pristine purity by heat, it nevertheless diminishes in weight by such treatment. As a curiosity it is sometimes made into gloves ; and is used for lamp wicks, and for several philosophical purposes. It is prepared (according to the *Annales d'Hygiene Publique*, January 1830) by exposing amianthus to the action of steam, by which the fibres are loosened, and acquire sufficient flexibility to admit of being easily separated.

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Though Augite and Hornblende were distinguished by Werner, and his proposal to separate them has obtained the sanction of Haüy, Mohs, and every mineralogist since his time, there certainly are few species in the mineral kingdom whose characteristic features are more difficult to ascertain. Their hardness is identical ; their specific gravity, although among the varieties of augite it rises higher than in hornblende, is indecisive ; their analyses only prove that augite usually contains more lime, less alumina, and no fluoric acid, which is peculiar, though in minute portions, to hornblende ; their comportment before the blowpipe does not differ materially ; nor do their colour, lustre, streak, or appearance, afford the mineralogist the slightest assistance. His only resource, then, is the crystalline form and structure of the two species, with some regard perhaps to the position and circumstances under which they occur. Augite presents slightly oblique four-sided prisms, while those of hornblende are very oblique. Their internal structure also differs ; hornblende possessing a perfect cleavage parallel to *M*, and an imperfect one parallel to *x*, while in augite the planes of cleavage are generally imperfect and interrupted, besides being inconstant.

As our mineralogical knowledge increases, the characteristics of these species afford still stronger grounds for identification. The proposal of Professor Gustav Rose, to unite them (*Poggendorff's Annalen*, vol. xxii.), is therefore founded on good reasons ; and we may hope ere long to have the relations of augite and hornblende so thoroughly ascertained, as no longer to leave their identity matter of dispute.

It is well known that augite and hornblende seldom occur together ; and that when they do, it is only in trachytic rocks and lavas of late date, in which the one forms crystals in the cavities, the latter a portion of the mass. The frequency of augitic forms, and the non-occurrence of hornblende, among crystalline slags ;—the results of Mitscherlich and Berthier's experiments in producing augite artificially, while they never succeeded in forming hornblende ;—and, lastly, the ge-

neral occurrence of hornblende associated with quartz, felspar, albite, and other minerals, in masses which must have cooled slowly, while augite is most frequently accompanied by olivine, and has experienced a rapid decrease of temperature;—all concurred in leading Rose to conclude, that the variety of crystalline forms presented by the two substances, depended entirely on the more or less rapid cooling to which they have been exposed. Upon fusing, in consequence, a mass of hornblende in a porcelain furnace, he found that it did not, on cooling, assume its previous shape, but invariably took that of augite. This circumstance, confirmed by his possessing several specimens collected in Siberia, whose crystals present a hornblende cleavage, while they have the external form of augite, has elucidated the valuable discovery so ably announced in Poggendorff's *Annalen* for 1831.

#### ARFWEDSONITE.

Peritomous Augite Spar, *M. Brooke*, *Ann. of Phil.* XXIX. 381. *Thomson*, *Ann. of Lyceum*, New York, 1828.

Sp. Gr. 3·4—3·5.  $H. = 6\cdot0$ .

Prismatic. Has not been observed regularly crystallized. *Colour* black. *Opake*. *Lustre* vitreous. *Cleavage* in two directions, intersecting at an angle of  $123^{\circ} 55'$ . Planes of cleavage very brilliant. Contains silica 50·50, peroxide of iron 35·14, deutoxide of manganese 8·92, alumina 2·49, lime 1·56, water 0·96—*Thomson*. According to *Children*, it fuses readily into a black globule, when exposed in the platina forceps to the blow-pipe. With borax it yields a glass coloured by iron; with salt of phosphorus the same, but paler, colourless on cooling, and leaving a silica skeleton undissolved.

#### OBSERVATIONS.

Arfwedsonite bears great resemblance to, and used to be considered a ferriferous variety of hornblende, until distinguished, in consequence of its greater specific gravity and difference of angle, by *Brooke*, who named it in honour of Professor Arfwedson. It is found accompanying sodalite and eudialite at Kangerdluarsuk in Greenland.

#### EPIDOTE.

Prismatoidal Augite Spar, *M.* Prismatoidal Augite, *J.* Epidote, Zoisite, *P.* Pistazit, Piemontischer-Braunstein, *W.* Akanticone, Scorza, Thallit, *H.*

Sp. Gr. 3·2—3·5.  $H. 6\cdot0—7\cdot0$ .

Hemi-prismatic. FIG. 112. Inclination of  $r$  to  $T = 128^{\circ} 19'$ , of  $r$  to  $M = 116^{\circ} 17'$ , of  $M$  to  $T = 115^{\circ} 24'$ , of  $n$  to  $n = 109^{\circ}$



27'. Colour green, pistachio-green, grey, or dark-red. Semi-transparent or translucent. Lustre vitreous, inclining to pearly upon the perfect faces of cleavage, and the corresponding faces of crystallization. Cleavage perfect parallel to M, less so to T. Fracture uneven. Streak greyish-white. Contains,

	Zoisite, Carinthia.	Pistazite, Isere.	Arendal.
Silica	45.0	37.0	37.0
Alumina	29.0	27.0	21.0
Lime	21.0	14.0	15.0
Oxide of iron	3.0	17.0	24.0
Ox. of manganese	0.0 Klap.	1.5 Descostes.	1.5 Vauq.

Before the blowpipe the varieties of the present species intumesce, but are difficultly fusible. Those which contain a larger portion of iron fuse more readily, and form a brown scoria. With borax it yields either a limpid globule, or one tinged with iron, according to its constituents, unless manganese predominates, and then in the oxidating flame it assumes an amethystine tinge.

## OBSERVATIONS.

This species comprehends Zoisite and Pistazite, which may be distinguished by their colours, the first being white or grey, the second green. The dark-red coloured variety from St Marcel in the valley of Aosta in Piemont, named by Werner *Piemontisher Braunstein*, and by Haüy *epidote manganesifere*, is a kind of zoisite impregnated with oxide of manganese, sometimes to the amount of 12 per cent. The magnificent crystals of epidote from Arendal in Norway, hence called *Arendalite*, often consist of concentric coats, the exterior of which admit of removal, and thus, like idocrase, out of a large imperfect crystal, one of smaller size, but more completely formed, may be evolved with facility. Large translucent dark-coloured individuals of the same description have been met with at Aggruvan near Normark in Sweden. At Bourg d'Oisans in Dauphiné, beautiful pistachio-green groups, composed of slender prisms, are found; and in many other parts of Europe it is not an uncommon mineral, though rarely so distinct. Zoisite is found accompanying kyanite, hornblende, and titanium, in the Sau Alpe and the Bacher Mountain in Styria; in the Fichtelgebirge; and in the Tyrol, of a brownish colour. Epidote, having a compact, fibrous, and radiated structure, occurs at Mount Civellina in the Vicentine; in small quantities also in different counties of Great Britain. *Scorza* is a name given by the inhabitants of Transylvania to the granular variety which occurs in the form of sand, on the banks of the river Arangos. Withamite and Thulite (page 156) are generally arranged along with the red varieties of this species.

## WOLLASTONITE.

Prismatic Augite Spar, *M.* Prismatic Augite or Tabular Spar, *J.* Schaalstein, *W.* Tafelspath, *L.* Spath en Tables, Wollastonite, *H.*

Sp. Gr. 2·7—2·9. H. = 4·5—5·0.

Seldom crystallized, generally in fibrous prismatic concretions. *Colour* white, inclining to grey, yellow, and brown. Semi-transparent or translucent. *Lustre* vitreous, inclining to pearly, particularly on the perfect faces of cleavage. *Streak* white. *Cleavage* parallel to two faces which intersect each other at an angle of  $95^{\circ} 25'$ , both easily obtained, but one of them more perfect and smooth. *Fracture* uneven. It has yielded,

			Pargas.
Silica	51·45	51·60	52·58
Lime	47·41	46·41	44·45

Oxide of iron 0·40 Strom. a trace. Rose. 1·13 Bonsdorff. which corresponds to the chemical formula for 47·24 of lime, and 52·76 of silica. Before the blowpipe it melts on the edges into a semi-transparent colourless enamel; but requires a very strong heat to produce perfect fusion. It melts readily, and forms a transparent colourless glass, with borax. If scratched with a knife, it emits a phosphorescent light; and when thrown into nitric acid, effervesces quickly at first, and finally falls to powder. In this respect it differs from all the varieties of augite, which are insoluble in acid.

## OBSERVATIONS.

Wollastonite occurs in small tabular crystals, associated with mica and idocrase, occupying the cavities of ejected stones, in the vicinity of Vesuvius; they are extremely fragile, however, and the terminations so often broken, that their forms, even from this locality, are difficultly determinable. It occurs in fibrous prismatic concretions, associated with apophyllite and copper pyrites, in the copper mines of Cziklowa in the Bannat of Temeswar. At Pargas in Finland, and at Kongsberg in Norway, it is met with in limestone, accompanied by garnet, fluor, and native silver; and at the Castle rock of Edinburgh it occurs, with prehnite, in fibrous radiated masses, imbedded in basalt; also in several parts of America, and with essonite in Ceylon. Wollastonite is one of the few minerals which can be produced artificially, cleavable masses having been obtained by fusing lime and silica in the required proportions. A white fibrous mineral, latterly found in the greenstone of Corstorphine Hill, near Edinburgh, is described in *Phil. Jour.* for Oct. 1833 as Wollastonite, to the Bannat variety of which it bears considerable resemblance. It



does not however effervesce with acids, and before the blowpipe *per se* fuses with intumescence into a hard white enamel. It contains, according to Walker, silica 54·0, lime 30·79, soda 5·55, water 5·43, magnesia 2·59, with a little alumina and oxide of iron; it phosphoresces when heated, emitting a feeble white light; and closely resembles the Castle-rock variety, described by Dr Kennedy in the Royal Society Transactions so early as the year 1802. Dr Thomson's analysis of Wollastonite, from the latter locality (Royal Soc. Trans., xi. 458), refers to the prehnite which accompanies it; and the mineral he describes as occurring in greenstone veins at Kilsyth is evidently something distinct.

### BUCKLANDITE.

Dystomic Augite Spar, *Haid.* *Levy* in Ann. Phil. Feb. 1824.

Harder than augite.

Hemi-prismatic. FIG. 113. Inclination of P to *m* =  $103^{\circ} 56'$ , of *m* to *m* =  $70^{\circ} 40'$ , of *m* to *h* =  $125^{\circ} 20'$ , of P to *h* =  $114^{\circ} 55'$ , of P to *a* =  $99^{\circ} 41'$ . Colour dark brown, nearly black. Opaque. Lustre vitreous. Cleavage not observable. Fracture uneven.

### OBSERVATIONS.

This very rare mineral has much general resemblance to augite. It was distinguished and described by Levy, to whom we are indebted for the above measurements. It occurs at Arendal in Norway, with black hornblende, felspar, and apatite. In general the crystals are small, but the collection of Mr Monrad of Copenhagen contains one detached and very perfect individual, about an inch and a half in length, by fully five lines in breadth. Professor G. Rose observed this mineral in the lavas of the Lacher-See, in minute but very brilliant crystals; he found their specific gravity 3·945, and describes them as completely soluble in muriatic acid.

### AMBLYGONITE.

Amblygonic Augite Spar, *Haid.* Amblygonite, *J.* and *P.*

Sp. Gr. 3·0—3·04. H. = 6·0.

Massive; and in oblique four-sided prisms of  $106^{\circ} 10'$ , and  $73^{\circ} 50'$ . Colour pale mountain- or sea-green. Semi-transparent or translucent. Lustre vitreous, inclining to pearly. Streak white. Cleavage parallel to the faces of the prism. Fracture uneven. Before the blowpipe it fuses easily, intumescs, and on cooling becomes opaque. With borax it melts into a transparent colourless glass.

## OBSERVATIONS.

Amblygonite was distinguished as a particular species by Breithaupt. It has hitherto been found only at Chursdorf, near Penig, in Saxony, where it occurs in granite, along with tourmaline and topaz. According to Berzelius, it consists of alumina, phosphoric and fluoric acids, and lithia in greater quantities than any other mineral; no distinct analysis, however, has yet been made.

## JEFFERSONITE.

Jeffersonite, *P.* Polystomous Augite Spar, *Keating*. Edin. Phil. Jour. VII. 317.

Sp. Gr. 3.5—3.6. H. = 4.5.

Hemi-prismatic. In lamellar or crystalline masses. *Colour* dark-olive green, passing into brown. Almost opaque. *Lustre* resinous, except on the faces of cleavage, which are semi-metallic. *Streak* light green. *Cleavage* distinct in three directions, two of them forming prisms of  $106^\circ$ , the other slightly inclined to their axis. *Fracture* uneven. Contains silica 56.0, lime 15.1, protoxide of manganese 13.5, peroxide of iron 10.0, oxide of zinc 1.0, alumina 2.0—*Keating*. Fuses readily before the blow-pipe into a black globule, but has no effect upon the magnet, nor do acids act upon it when cold; in heated muriatic acid, however, a portion is dissolved, and what remains becomes of a lighter colour.

## OBSERVATIONS.

Jeffersonite occurs at the Franklin iron-works, near Sparta, in Sussex County, New Jersey, with magnetic iron ore, Franklinite, garnet, and chondrodite. It is nearly allied to augite, though inferior in hardness, and having a somewhat higher specific gravity than that mineral. The chemical analysis offers another important difference in the absence of magnesia, which appears to be essential to augite. It frequently presents an earthy aspect, which indicates the commencement of decomposition.

## ACMITE.

Akmit, *Haid.* Achmite, *Strom.* Edin. Phil. Jour. April 1823. Brews. Jour. Oct. 1826.

Sp. Gr. 3.24—3.38. H. = 6.0—6.5.

Hemi-prismatic. FIG. 114. Inclination of *M* to *M* over *r* =  $86^\circ 56'$ , of *s* to *s* =  $119^\circ 30'$ ; of the edge between *s* and *s* to the face *r* =  $106^\circ$ ; the angle *abc* =  $28^\circ 19'$ . Frequently macle parallel to *r*. *Colour* brownish black. Opaque. When thin translucent, and exhibiting a fine yellowish brown tint.



*Lustre* vitreous. *Streak* pale yellowish grey. *Cleavage* distinct parallel to M, less so parallel to *r*, *l*, and *s*. *Fracture* imperfect conchoidal. Surface *r* irregularly streaked in a longitudinal direction. Brittle. Contains silica 55·25, oxide of iron 31·25, oxide of manganese 1·08, lime 0·72, soda 10·40—Berzelius. It melts readily before the blowpipe into a black globule.

## OBSERVATIONS.

This is also a scarce mineral, its only known locality being Rundemyr, about four miles north of Dunsrud, near Kongsberg in Norway. It there occurs in crystals occasionally nearly a foot long, imbedded in granite and quartz. They are, however, frequently maced and bent, and in consequence of their frangibility are not easily disengaged from the matrix. Its name is derived from *ακμν*, a point, from the form of its crystals; the above figure represents a very perfect one in my father's collection.

## SILICATE OF MANGANESE.

Manganese Spar, *J.* Siliferous Oxide of Manganese, *P.* Manganspath, *W.*

Sp. Gr. 3·5—3·7. H. = 5·0—5·5.

Crystalline form unknown. Massive. *Colour* rose red. Translucent on the edges. *Lustre* intermediate between pearly and resinous. *Cleavage* apparent in two directions perpendicular to each other. Contains

Oxide of manganese	52·60	49·04
Silica	39·60	48·00
Oxide of iron	4·60	a trace.
Lime and magnesia	1·50	3·34
Water	2·75 Berzelius.	0·00 Rose.

Before the blowpipe it becomes dark brown, and melts into a reddish-brown globule. It imparts to glass of borax in the oxidating flame a hyacinth-red colour, but in the reducing flame the glass remains white.

## OBSERVATIONS.

It occurs at Langbanshyttan, near Phillipstadt in Sweden, in beds of iron ore, sometimes presenting large foliae, at others a fine granular composition, and in that case the colour is generally paler; also at Elbingeroode in the Hartz; in the district of Ekatherineburg in Siberia; with fahlerz at Kapnick in Transylvania; at Franklin, New Jersey, U. S.; and associated with black oxide of manganese, near Callington in Cornwall. Dr Thomson, in the Annals of Lyceum of New York, April 1828, gives descriptions and analyses of no less than four species of silicate of manganese from New Jersey, besides this which he distinguishes as a bisilicate.

The substances called *Allagite*, *Photizite*, *Rhodonite*, and *Corneous Manganese*, all from the vicinity of Rubeland in the Hartz, are evidently compact varieties of this species, under different states of oxidation, and in more or less perfect conditions of purity.

### WITHAMITE.

*Brewster, Journal, II. 218.*

Sp. Gr. 3.1—3.3. H. = 6.0—6.5.

Hemi-prismatic. FIG. 112. Inclination of  $r$  to  $T = 128^\circ 20'$ , of  $M$  to  $T = 116^\circ 40'$ . Colour carmine red, or pale straw-yellow, when seen in certain directions by transmitted light. Translucent. Lustre vitreous. Streak white. Before the blowpipe it intumescs, and fuses with difficulty into a dark greenish-grey scoria; with salt of phosphorus it forms a globule, which contains a skeleton of silica, and becomes opaque on cooling. It is not acted upon by acids; but silica, iron, and manganese are unequivocally indicated among its constituents.

#### OBSERVATIONS.

This mineral was distinguished, and described by Sir D. Brewster under its present name, in compliment to Mr Witham, who discovered it some years ago in Glenco, in Argyleshire. It there occurs both in minute transparent brilliant red crystals, radiating from a centre, and massive, filling small cavities in a species of compact reddish trap. It bears much analogy to epidote, and in colour resembles the following species.

### THULITE.

Thulite, P. Brooke, Crystallography, p. 494.

H. = 6.0.

In crystalline masses of a rose-red colour; the form, when visible, resembling that of epidote. Translucent. Streak greyish-white. Cleavage in two directions parallel to the sides of a rhombic prism of  $92^\circ 30'$  and  $87^\circ 30'$ ; no distinct cleavage transverse to the axis of this prism.

#### OBSERVATIONS.

The Thulite of Brooke occurs at Tellemarken, in Norway, accompanying quartz, fluor, and cyprine. It is considered by mineralogists (as is Withamite also) to be an indistinct variety of epidote, the characters of both, in so far as they have been ascertained, closely corresponding with that species. Haidinger, however, having separated them, I retain his arrangement provisionally.



## LAZULITE.

Prismatic Azure Spar, *M.* and *J.* Lazulite, Azurite, *P.* Lazulit, *W.* and *H.*

Sp. Gr. 3·0—3·1. H. = 5·0—6·0.

Prismatic. *Colour* various shades of azure blue. Slightly translucent, or opaque. *Lustre* vitreous. *Streak* white. *Cleavage* indistinct. *Fracture* uneven. Brittle. Consists of, phosphoric acid 41·81, alumina 35·73, magnesia 9·34, silica 2·10, protoxide of iron 2·64, water 6·06—Fuchs.

Before the blowpipe it slightly intumesces, and assumes a glassy appearance where the heat has been highest, but does not melt. With borax it yields a clear colourless globule; and when treated with boracic acid and iron wire, affords a globule of phosphuret of iron.

## OBSERVATIONS.

It is found in narrow veins, traversing clay-slate, both massive and crystallized, in the torrent beds of Schlamming and Radel-graben, near Werfen, in Salzburg. When on the spot in 1830, I was fortunate enough to pick up a very distinctly crystallized specimen of this substance, which in that form is extremely rare, for, besides being brittle, the specimens are usually much rubbed in the channel of the river; it more commonly occurs disseminated in small masses. It is found also in a gangue of quartz near Voralpe, in Styria, and has hence received the name of *Voralp-lite*.

## CALAITE.

Uncleavable Azure Spar, *M.* Calaite or Mineral Turquoise, *J.* Calaite, *P.*

Sp. Gr. 2·8—3·0. H. = 6·0.

In reniform masses of a peculiar greenish-blue colour. Feebly translucent on the edges, or opaque. *Lustre* waxy, rarely splendid; internally dull. *Streak* white. *Cleavage* none. *Fracture* conchoidal. Becomes brown in the reducing flame of the blowpipe, and colours it green, but does not fuse; with borax or salt of phosphorus, however, it melts easily. It is insoluble in muriatic acid, by which character it may be distinguished from artificial or occidental turquoise. According to Berzelius, it consists of phosphate of alumina and phosphate of lime, silica, the oxides of iron and copper, and a little water; while John

noticed alumina 73·0, oxide of copper 4·5, oxide of iron 4·0, and water 18·0.

## OBSERVATIONS.

*Oriental* turquoise occurs either in pebbles, or in small veins traversing alluvial clay, in the Persian Khorasan. Nishapiú and Firuzkúh are its most noted localities; and it is found on sale, generally in small masses, but in great quantity, in all the large towns of Persia. The *occidental* turquoise, found near the town of Simor, in Lower Languedoc, is a very different substance, being, according to the analysis of La Grange, bone, coloured with phosphate of iron. Calaite, cut and polished, is used for ornamental purposes, and, when well coloured, is a valuable and much esteemed gem.

Malachite, with which turquoise may sometimes be confounded, yields a green streak; while that of calaite is white.

## SAUSSURITE.

Prismatic Nephrite Spar, *Haid.* Saussurite, *J. and P.* Jade Tenace, *H.*

Sp. Gr. 3·2—3·4. H. = 5·5.

Massive. *Colour* greenish-white, mountain-green, or ash-grey. *Lustre* pearly, inclining to vitreous on the faces of cleavage; resinous in compound varieties. Translucent on the edges. *Streak* white. *Cleavage* in two directions, parallel to faces which meet at an angle of 124° nearly. Unctuous to the touch. *Fracture* uneven, splintery. Extremely tough, and difficultly frangible. Contains,

Silica	49·00	44·00
Alumina	24·00	30·00
Lime	10·00	4·00
Magnesia	3·75	Potash 0·25
Oxide of iron	6·50	12·50
Oxide of manganese	0·00	0·05
Soda	5·50 Klap.	6·00 Saussure.

Before the blowpipe it fuses with difficulty into a white glass.

## OBSERVATIONS.

Saussurite was first discovered by the distinguished traveller and mineralogist whose name it bears, in rounded masses, on the edge of the lake of Geneva. It occurs in primitive mountains; as at Monte Rosa and its vicinity, in Corsica, in Greenland, at Madras, and elsewhere; constituting, with augite and hornblende, the rocks called gabbro and euphotide.



## NEPHRITE.

Uncleavable Nephrite Spar, *Haid.* Nephrite, *J.* Common Jade, *P.* Jade Nephritique, *H.*

Sp. Gr. 2·9—3·05. H. = 7·0.

Massive. Composition impalpable. *Colour* leek-green, passing into grey and white. Translucent on the edges. Sometimes particularly tough. *Fracture* coarse splintery. It consists of, silica 50·50, magnesia 31·00, alumina 10·00, oxide of iron 5·50, oxide of chrome 0·05, water 2·75—Kastner.

It is infusible *per se* before the blowpipe but becomes white, and with borax forms a transparent glass.

## OBSERVATIONS.

The true Jade is brought from China and Egypt; from the former in a manufactured state. It is an extremely tough hard substance, eliciting sparks when struck with steel; and the vessels made of it are as sonorous as porcelain. The New Zealanders work it into hatchets.

## EUDIALITE.

Rhombohedral Almandine Spar, *Haid.* Eudialyte, *J.* and *P.*

Sp. Gr. 2·89—2·9. H. = 5·0—5·5.

Rhombohedral. FIG. 115. Inclination of P to P over  $u = 106^{\circ} 36'$ . *Colour* brownish-red. Slightly translucent or opaque. *Lustre* vitreous. *Streak* white. *Cleavage* parallel to  $a$ , very perfect; less so parallel to  $z$ . *Fracture* conchoidal or uneven. Consists, according to two analyses by Stromeyer, of

Silica	52·47	53·32
Zirconia	10·89	11·10
Lime	10·14	9·79
Soda	13·92	13·82
Oxide of iron	6·85	6·75
Oxide of manganese	2·57	2·06
Muriatic acid	1·03	1·03
Water	1·80	1·80

Before the blowpipe it fuses into a leek-green scoria, and, if reduced to powder, gelatinizes with acids.

## OBSERVATIONS.

This was first distinguished as a new species by Stromeyer, who gave it the title of eudialite, in allusion to its ready solubility in acids. My father's collection contains one very perfect individual, fully an inch in diameter, which was brought to this country by Gièsécke; but in general

the crystals are much smaller. Its only locality is Kangerdluarsuk in West Greenland, where it occurs both crystallized and massive, either associated with hornblende and sodalite, or imbedded in compact white felspar.

#### BERGMANNITE.

Sp. Gr. 2·3. H. about 5·0.

Bergmannite. *Schumacher, J. P. and H.*

Massive; and in promiscuous fibrous concretions. *Colour* greyish, passing into white, and brick red. *Opake.* *Lustre* pearly. Before the blowpipe it becomes white, and fuses without effervescence into a colourless glass.

#### OBSERVATIONS.

It occurs at Stavern in Norway along with felspar, elaolite, and quartz, and is by Leonhard and some other mineralogists considered a variety of scapolite. It is named in honour of the illustrious Swedish chemist Bergmann.

#### CHIASTOLITE.

Chiastolite, *P. Hohlspath, W. Macle, H.*

Sp. Gr. 2·9—3·0. H. = 5·0—5·5.

Prismatic. Crystallized in rectangular prisms, which present a black cross in their transverse section. *Colour* white or grey, the dark portion black or bluish-black. Translucent. *Lustre* vitreous, though indistinct. *Streak* white. *Cleavage* imperfect. *Fracture* splintery. Contains silica 68·49, alumina 30·17, magnesia 4·12, oxide of iron 2·7, water 0·27—Landgrabe; which corresponds with the researches of Berzelius, who ascertained it to be a compound of silica and alumina. Before the blowpipe the white portion becomes still whiter, but does not fuse; while the black melts into a dark-coloured glass. With either borax or salt of phosphorus it is difficultly fusible, forming a transparent glass; but it effervesces, and is entirely soluble in nitric acid.

#### OBSERVATIONS.

This substance takes its name from the Greek, in allusion to the summits of its crystals being marked with the form of an X. It occurs imbedded in clay-slate or schistus in many places, particularly near Bareges, in the Pyrenees; at St Jago di Compostella in Spain; in clay-slate near Santa Elena in the Sierra Morena, as observed by Dr Traill; at Bretagne in Normandy; on Skiddaw in Cumberland; and at Agnavanagh in Wicklow. Haüy supposes the crystals to be produced by the union of two individuals similarly crystallized, the one in a state of purity, the other a mixture.



## GEHLENITE.

Sp. Gr. 3·0—3·05. H. = 5·5—6·0.

In rectangular four-sided prisms, approaching the form of the cube. *Colour* different shades of grey, not bright. *Opake*. *Lustre* resinous, inclining to vitreous. Surfaces commonly rough and dull; when sufficiently brilliant for the use of the goniometer, they afford angles of  $90^\circ$  in every direction. *Cleavage* parallel to the summit of the prism, indistinct. *Fracture* uneven and splintery. Consists of alumina 24·80, silica 29·64, lime 35·30, oxide of iron 6·56, water 3·30—Fuchs.

It is very difficultly fusible before the blowpipe, and then only in thin splinters; also with borax it melts slowly, forming a glass coloured by iron. It gelatinizes in heated muriatic acid.

## OBSERVATIONS.

Gehlenite occurs principally on Mount Monzoni, in the Fassa valley, in crystals which frequently exceed half an inch in diameter, either isolated and invested by calcareous spar, or aggregated irregularly in groups. They sometimes present a yellowish coating, which is the effect of decomposition, and do not admit of being disengaged from their matrix by acid, their surfaces presenting a rough fissured appearance when the calc spar is in this manner removed. Gehlenite likewise occurs massive, forming an extremely tough, difficultly frangible rock, with imbedded crystals of pleonaste, in the same vicinity. It was described, and named by Fuchs in honour of his colleague Gehlen. Monticelli mentions gehlenite among the minerals of Vesuvius, where it is found indistinctly crystallized, imbedded in calcareous spar.

## KARPHOLITE.

Karpholite, *J.* Carpholite, *P.*

Sp. Gr. 2·9—3·0. H. = 5·0.

Massive, having a fibrous, radiated, or stellular structure, which is rather incoherent. *Colour* high straw yellow (whence its name), sometimes approaching to wax-yellow. *Opake*. *Lustre* silky. Very brittle. It intumesces before the blowpipe, becomes white, and fuses slowly into a brown opake mass. With borax it forms a transparent glass, which in the outer flame presents the amethystine colour of manganese, and in the reducing flame becomes green.

It consists of Silica	37.53	36.15
Alumina	26.48	28.67
Prot. of mang.	17.09	19.16
Prot. of iron	5.64	2.29
Lime	0.00	0.27
Fluoric acid	0.00	0.47
Water	11.36 Steinm.	10.78 Strom.

## OBSERVATIONS.

Karpholite occurs in minute diverging tufts, disposed on granite, and associated with fluor and quartz, in the tin mines of Schlaggenwald in Bohemia.

## SILLIMANITE.

*Bowen*, Jour. of Philadelphia Acad. of Sciences, III. 375. *Phillips*, Ann. of Phil. June 1827.

Sp. Gr. 3.41. H. = 6.0—6.5.

In oblique rhombic prisms of  $106^{\circ} 30'$ , the inclination of the base to the axis being  $113^{\circ}$ . *Colour* dark grey, passing into clove brown. Translucent on the edges. *Lustre* vitreous, considerable on the face of cleavage, which is parallel to the shortest diagonal of the prism. *Fracture* uneven, splintery. Brittle, and easily reduced to powder.

Alumina	54.11	35.11
Silica	42.67	38.67
Oxide of iron	2.00	7.22
Water	0.51	0.00
Zirconia	0.00—Bowen.	18.51—Thomson.

It is infusible before the blowpipe, whether alone or with borax, and is not acted upon by acids.

## OBSERVATIONS.

This mineral is found imbedded in quartz; its prisms, being therefore frequently bent or twisted, and their planes generally far from bright, and somewhat convex, seldom admit of accurate measurement. It occurs in the county of Saybrook, Connecticut, and used to be considered a variety of anthophyllite, which in several respects it closely resembles. Its large proportion of zirconia must have been confounded by Bowen with alumina, the results of the above analyses being otherwise nearly similar. It was named by Mr Bowen of Philadelphia, in honour of Professor Silliman of Yale College.



## BIOTINE.

Biotina, *Monticelli*. Mineralogia Vesuviana, 438.

Sp. Gr. 3.11. Scratches glass.

*Colour* white or yellowish. *Transparent* and limpid. *Lustre* brilliant. *Fracture* vitreous, inclining to conchoidal. Presents double refraction. Is not affected by the blowpipe, and is only partly soluble in nitric acid.

## OBSERVATIONS.

Sig. Monticelli noticed this mineral among the volcanic debris of Vesuvius, and named it in honour of M. Biot. It is easily distinguished from other species with which it is associated, by the superior brilliancy of its lustre.

## SOMERVILLITE.

Brooke. Quar. Jour. of Science, XVI. 275.

H. under 6.0.

FIG. 63. Having the edges between *g* and *l* replaced. Inclination of *c* to *g* =  $122^{\circ} 55'$ , of *P* to *c* =  $147^{\circ} 5'$ , of *P* to *l* =  $90'$ , of *l* to *g* =  $135'$ , of *l* to *l* =  $90^{\circ}$ . *Colour* pale dull yellow. *Lustre* vitreous. *Cleavage* perfect parallel to *P*.

It decrepitates before the blowpipe, fusing *per se* into a grey-coloured globule, and with borax into a transparent one.

## OBSERVATIONS.

Somervillite occurs among the ancient scoria of Vesuvius, associated with black mica and other minerals. The determination of this species is due to Brooke, who named it in compliment to Dr Somerville, from whom he obtained the specimens. It may be distinguished from idocrase by its comportment before the blowpipe, as the latter does not decrepitate; and when it fuses, which it does with greater difficulty, it yields globules of a greenish tinge.

## ORDER GEM.

### ANDALUSITE.

Prismatic Andalusite, *M.* Andalusit, *W.* Feldspath Apyre, *H.*

Sp. Gr. 3·0—3·2. H. = 7·5.

Prismatic. In four-sided prisms, which are slightly rhombic, their angles being  $91^{\circ} 33'$  and  $88^{\circ} 27'$ . *Colour* reddish, passing into pearl-grey. Translucent on the edges, or opake. *Lustre* usually faint. *Streak* white. *Cleavage* distinct, parallel to both faces of the prism. When massive extremely tough.

Contains Alumina	60·5	52·0
Silica	36·5	38·0
Oxide of iron	4·0	2·0
Potash	0·0 Bucholz.	8·0 Vauquelin.

It is infusible before the blowpipe, even in the thinnest splinters ; and, when accompanied with borax, and reduced to powder, melts with extreme difficulty into a transparent colourless glass.

#### OBSERVATIONS.

In the Linsenz valley, above Innspruck in the Tyrol, where this mineral is found in very large crystals, it is accompanied with another substance, which presents the same form, and has hence been erroneously taken for grey andalusite ; the crystals of this substance are, however, certainly pseudomorphic, their hardness amounting to only 5·0, while their specific gravity exceeds 3·5. Andalusite belongs exclusively to primitive mountains ; it was first noticed in the province of Andalusia in Spain, hence its name, and latterly also near Braunsdorf in Saxony ; at Guldenstein in Moravia ; in Bavaria ; and Siberia. At Botrifney in Banffshire, it occurs imbedded in gneiss ; and in Killiney Bay, county Wicklow, in mica slate. Andalusite may be distinguished from felspar by its superior hardness and its infusibility, and from corundum by its structure and lower specific gravity. Mr Beudant unites it with chiastolite, which it somewhat resembles in specific gravity and form.



## SPINEL.

Dodecahedral Corundum, *M.* and *J.* Spinelle Ruby, Ceylanite, Pleonaste, *P.* Spinel, Zeilanit, *W.* Alumine Magnésiée ou Spinelle, *H.*

Sp. Gr. 3·5—3·8.  $H. = 8\cdot0$ .

Tessular. The regular octahedron ; occasionally macled, as represented in fig. 116. *Colour* various, passing through every shade of red, into green, blue, and black. Transparent, translucent only on the edges if the colour be very dark. *Lustre* vitreous. *Streak* white. *Cleavage* parallel to the faces of the octahedron, though not easily obtained. *Fracture* conchoidal. Contains

	<i>Blue, Aker.</i>	<i>Red Spinel.</i>	<i>Pleonaste, Ceylon.</i>
Alumina	72·25	74·50	68·00
Silica	5·45	15·50	2·00
Magnesia	14·63	8·25	12·00
Oxide of iron	4·26	1·50	16·00
Lime	0·00 Berz.	0·75 Klap.	0·00 Desc.

The Berzelian formula for the pure varieties corresponds to 83·25 alumina, and 16·75 magnesia.\* Pleonaste contains, besides, a large portion of oxide of iron, which accounts for its specific gravity being usually somewhat higher than that of spinel. This species *per se* is infusible before the blowpipe. The red varieties become brown, and even black and opaque, as the temperature is increased ; but on cooling they appear first green, then almost colourless, and at last resume their red colour. They are difficultly fusible with borax, but a little more easily with salt of phosphorus, the pleonaste yielding a deep-green globule, from the large amount of iron it contains.

## OBSERVATIONS.

The term Spinel or Spinel-Ruby distinguishes the red and violet coloured varieties from such as are nearly or perfectly black, and to which Haüy applied the name of Pleonaste. Among lapidaries the scarlet-coloured is properly denominated *Spinelle Ruby*, the rose-red *Balas Ruby*, the yellow or orange-red the *Rubicelle*, and the violet-coloured *Almandine Ruby*. It must, however, be distinguished from oriental ruby or red

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\* Poggendorf, Ann. xxiii. 365, contains an interesting series of analyses of these varieties by Abich, a pupil of Professor Mitscherlich, in which the amount of magnesia is stated considerably higher.

sapphire, a gem belonging to the species corundum, and of even greater rarity. Spinel is principally found in Ceylon, Siam, and other eastern countries, where it occurs, like most other gems, in isolated and rolled crystals, in the channels of rivers. Being less hard and less heavy than oriental ruby, it may be distinguished from that substance with facility even when cut. From garnet it is sufficiently characterized by its lighter colour; and from red topaz, the tinge of which is produced artificially, it is known by not possessing double refraction. At Aker in Sudermannland, Sweden, pale-blue and pearl-grey varieties occur in calcareous spar; while those properly denominated Pleonaste are met with either in isolated masses, near Candy in Ceylon (hence Bournon's name *candite* for this variety); or in very perfect splendid crystals, coating, with mica and idocrase, the drusy cavities of ancient scoria at Monte Somma. Pleonaste likewise occurs imbedded in compact gehlenite, at Monzoni, in the Fassathal; and has latterly been met with in distinct octahedrons, two or three inches in diameter, associated with chondrodite, at Amity, in the Orange County, U. S. The hardness and lustre of Spinel have given it a place among the gems; and when well coloured and pretty large, it is highly prized as an ornamental stone.

#### AUTOMALITE.

Octahedral Corundum, *M.* and *J.* Automalite, *P.* Gahnite, *L.* Spinell Zincifère, *H.*

Sp. Gr. 4.1—4.3. H. = 8.0.

Tessular. FIG. 116. In octahedrons of a dark green or black colour, generally macted. Nearly opaque. *Lustre* vitreous, inclining to resinous. *Streak* white. *Cleavage* perfect parallel to the faces of the octahedron. *Fracture* conchoidal. Contains

		Fahlun.	America.
Alumina	60.00	55.14	57.09
Oxide of zinc	24.25	30.02	34.80
Oxide of iron	9.25	5.85	4.55
Silica	4.75	3.84	1.22
Magnesia	0.00 Eckeberg.	5.25 Abich.	2.22 Abich.*

with traces of manganese and lime. Berzelius' formula corresponds to 71.86 alumina, and 28.14 oxide of zinc. It is infusible *per se* before the blowpipe, and nearly so with borax or salt of phosphorus. With soda it melts imperfectly into a dark-coloured scoria, which, on being again fused with the same re-agent, deposits upon the charcoal a circle of oxide of zinc.

\* Poggendorf, Ann. xxiii. 305.



## OBSERVATIONS.

It is found in dull but very perfect octahedrons, frequently macle, imbedded in talc slate, at the mines of Nafversberg and Eric Matts, near Falun in Sweden, and at the Franklin Iron Works, Sussex County, New Jersey. The celebrated Swedish chemist Gahn was its discoverer. Haüy and some other mineralogists have associated this species with the preceding, considering it a zinciferous pleonaste, which is a mistake.

## CORUNDUM.

Rhombohedral Corundum, *M.* Rhomboidal Corundum, *J.* Corundum, Emery, *P.* Sapphire, Salemstein, Schmirgel, Korund, Demantspath, *W.* and *L.* Telésie, Corindon, *H.*

Sp. Gr. 3.9—4.05. H. = 9.0.

Rhombohedral. FIG. 117. Inclination of *P* to *P*, the faces of the primitive rhomb, =  $86^{\circ} 6'$ . Colour blue, red, yellow, brown, and grey; the transparent blue varieties possessing considerably higher specific gravity than such as are red. Transparent or translucent. Lustre vitreous, inclining in some specimens to pearly on the face *o*. Streak white. Cleavage parallel to *o*, imperfect in the varieties of sapphire. Fracture conchoidal, uneven. When compact, extremely tough, and difficultly frangible. Contains

	<i>Sapphire.</i>	<i>Corundum Stone.</i>	<i>Emery.</i>
Alumina	98.5	89.50	86.0
Silica	0.0	5.50	3.0
Oxide of iron	1.0	1.25	4.0
Lime	0.5 Klap.	0.00 Klap.	0.0 Tennant.

Sapphire when pure consists of alumina alone, the Berzelian formula for corundum being expressive of 53.29 aluminum and 46.71 oxygen. It resists the action of the blowpipe both alone and with soda; but is entirely though with difficulty fusible in borax, and, if previously reduced to powder, also with salt of phosphorus. It is not acted upon by acids, but becomes electric when rubbed, a peculiarity which the transparent polished specimens preserve for a considerable time.

## OBSERVATIONS.

This species includes Sapphire, Corundum stone, and Emery; the first applying to such transparent simple varieties as are either colourless, or present blue, red, or yellow tinges; the second comprehending grey

and darker coloured opaque specimens ; while all compound massive varieties come under the denomination of emery.

The red sapphire, or *oriental ruby* as it is improperly termed, when perfect in transparency and colour, and of considerable size, vies with the diamond itself in value, one of four carats (according to Brard) being worth half the price of a perfect diamond of the same weight ; but it is seldom known to exceed half an inch in length, and does not occur in such large masses as the diamond. The king of Arracan, however, is said to have two enormous red sapphires, presenting six-sided pyramids “ de la longueur du petit doigt,” and nearly an inch across the base. Sapphire, properly so called, is met with either in six-sided prisms variously terminated, or in rolled masses in the beds of torrents. Its colour varies from a rich dark blue to a very slight tinge of the same, sometimes presents distinct colours in the same specimen, and frequently is transparent and colourless. The large sapphire in the collection at Göttingen, cut into something like the upper portion of a human figure with feet attached, and intended to represent Confucius, exceeds three inches in length by one and a half in breadth, and exhibits this peculiarity very distinctly ; the head being colourless, the feet dark blue, and the body of intermediate shades. The most magnificent specimens of this gem, however, are those contained in the London cabinets. Sir Abram Hume possesses a distinct crystal, which is three inches in length ; and in Mr Hope’s collection of precious stones, otherwise remarkably rich in sapphires, there is one formerly the property of the Jardin des Plantes, for which he gave the value of L.3000 sterling. The finest red sapphires occur in the Capelan mountains near Syrian, a city of Pegu, in the kingdom of Ava ; smaller individuals also near Billin and Mero-witz in Bohemia, and in the sand of the Expailie river in Auvergne. Blue sapphires are brought from Ceylon ; and to that variety in particular Werner applied the name of *salamstein*. Sapphires admit of the most perfect polish, being cut by means of diamond dust, and polished on copper or lead wheels with emery powder. The *asteria* or star sapphire presents, when cut *en cabochon*, in a direction perpendicular to the axis of the prism, a bright opalescent star of six rays, corresponding to its crystalline structure.

Corundum stone occurs in granitic rocks associated with felspar, fibrolite, magnetic iron, and other minerals, in the Carnatic, on the Malabar coast, in the territories of Ava, and elsewhere in the East Indies ; also in the vicinity of Canton in China, and in smaller quantities imbedded in magnetic iron at Gellivara in Sweden, at St Gothard of a red or blue tinge in dolomite, and near Mozzo in Piemont in white compact felspar. Such varieties as present a hair-brown colour are termed *adamantine spar* ; they are principally from the Malabar coast, occur in large coarse hexagonal pyramids, and, when cut transversely, exhibit a distinctly crystalline structure.

Emery or schmirgel is the same mineral uncrystallized. It is found



in large boulders in the neighbourhood of Smyrna; also at Naxos, and in several others of the Grecian islands. It occurs *in situ* with talc slate, at Ochsenkopf near Schneeberg in Saxony, of a dark blue or black colour, and presenting much the appearance of fine-grained basalt. Giè-sécke brought a small blue variety from Greenland.

This species yields a well-known grinding material. The compact variety, when pounded and moistened with a little water, is employed by the natives of India in cutting and polishing gems, rock crystals, and other hard stones; and in this country it is extensively used in burnishing steel and polishing hardware goods.

### CHRYSOBERYL.

Prismatic Corundum, *M.* Krisoberill, *W.* Cymophane, *H.*

Sp. Gr. 3.65—3.8. H. = 8.5.

Prismatic. FIG. 118. Inclination of *i* to *i* over the terminal edge = 119° 46'. Colour asparagus green, passing into greenish white. Transparent or translucent, sometimes presenting an opalescent appearance internally. Lustre vitreous. Streak white. Cleavage parallel to T, less distinct parallel to M. Fracture conchoidal and uneven. Consists of

	Brazil.	Brazil.	Brazil.	Haddam.	
Alumina	71.5	68.67	76.75	73.60	81.43
Glucina	0.0	16.00	17.79	15.80	0.00
Silica	18.0	6.00	0.00	4.00	18.73
Lime	6.0	0.00	0.00	0.00	0.00
Protox. of iron	1.5	4.73	4.49	3.38	0.00
Ox. of titanium	0.0	2.67	0.00	1.00	0.00
Moisture	0.0	0.66	0.48	0.40	0.00
	Klap.	Seybert.	Thomson.	Seybert.	Arfwedson.

Before the blowpipe it does not melt either alone or with soda, only in the latter case its surface becomes dull. It is difficultly, but entirely fusible, with borax or salt of phosphorus. When rubbed it becomes electric, but is not affected by heat.

### OBSERVATIONS.

There is evidently some discrepancy in the above analyses, for no mineral, so simple as chrysoberyl, could afford such different results, if the specimens under examination were pure. Dr Thomson could find no titanium, and the silica noticed by Seybert he conceives to have been abraded from the agate mortar; whereas, according to Arfwedson's analysis, it consists entirely of alumina and silica, and is moreover the first

species classified by Haüy under the title of *silice combinée avec l'alumine*. Near Haddam, in Connecticut, chrysoberyl occurs in large distinct crystals imbedded in granular albite with garnet, tourmaline, and tantalite. The finest specimens for lapidaries' purposes are however brought from Brazil, where, as in Ceylon, it occurs in the alluvial deposits of rivers, and consequently in rolled and generally much rubbed masses. When transparent, free from flaws, and of sufficient size, it is cut with facets, forming a brilliant yellow gem; but when it presents the peculiar milky or opalescent appearance, from which it derives the name of cymophane (or floating light), it is usually cut *en cabochon*. Sir David Brewster found its flaws and cavities to contain the peculiar fluids observed in certain minerals, although in quantities so extremely minute that the highest magnifying powers are required to render them visible. In a specimen about one seventh of an inch square, Sir David counted 30,000 of these fluid cavities; Brewster's Jour. v. 125. Chrysoberyl may be distinguished from moon-stone and opalescent quartz by its superior hardness, and from yellow topaz by not becoming electric when heated. It has been improperly termed opalescent chrysolite.

### DIAMOND.

Octahedral Diamond, *M.* and *J.* Demant, *W.* Diamant, *L.* and *H.*

Sp. Gr. 3.4—3.6. H. = 10.0.

**Tessular.** FIG. 119. Most simple form the octahedron, but, from the faces being generally rounded, its crystals assume a spherical appearance, as represented in the above tetracontaoctahedron; frequently macled, colourless, occasionally tinged yellow, red, orange, green, brown, or black. Transparent or translucent when dark-coloured. *Lustre* brilliant adamantine. *Streak* white. *Cleavage* highly perfect parallel to the faces of the octahedron. *Fracture* conchoidal. Consists of pure carbon, and is perfectly volatilized at a temperature of 14° Wedgewood, yielding, with oxygen, carbonic acid gas. Is not acted upon by acids or alkalies; possesses vitreous electricity when rubbed; and, after exposure to the solar rays, presents in the dark a distinct phosphorescence.

### OBSERVATIONS.

Separated as the diamond is from all other gems by its remarkable refractive power, and from all mineral substances by its extreme hardness, its chemical composition, and its locality in the crust of the earth, it has always been, and may still be, regarded as an anomalous substance. From its peculiar optical properties, and analogy in many respects with amber, Sir D. Brewster concludes that it originates, like that substance,



from the consolidation of perhaps vegetable matter, which gradually acquires a crystalline form by the influence of time, and by the slow action of corpuscular forces. The most remarkable circumstance in its history is, indeed, its chemical constitution. As early as the year 1607, Boëtius de Boodt suggested the idea of its being inflammable; Sir Isaac Newton pronounced it "an unctuous substance coagulated;" but Lavoisier first ascertained that, by throwing the solar rays, concentrated by a powerful lens, upon a diamond inclosed in a vessel of oxygen gas, the diamond was entirely consumed, and the oxygen replaced by a due volume of carbonic acid gas. Thus this most brilliant and valuable of all the gems is proved to be chemically identical with charcoal, from which it differs in molecular arrangement only. According to Pliny's account, the ancients were well acquainted with the diamond, and employed it for engraving and grinding other stones, but their ignorance of how it might be cut prevented them using it as a gem; and prior to the year 1476, when Bergnem of Bruges discovered in Europe the mode of grinding diamonds with their own powder, its natural crystals only were used as ornaments.

The matrix of the diamond is still undetermined, it having hitherto been found only in alluvial soil, or in the most recent rocks. Heyne, in his tracts on India, gives two representations of the diamond "in the rock;" but by his own account this rock consists of a conglomerate composed of rounded siliceous pebbles, quartz, calcedony, &c. cemented by a kind of ferruginous clay, in every respect analogous to the cascalho or alluvial deposit in which it is met with in South America. Mr Heuland possesses several specimens of a similar description, imbedded in a kind of clay iron ore. Hindostan and Brazil are its principal localities, and in both these countries it is confined to the tropics. In India, the diamond has been for ages an article of commerce; it is there met with in the district between Golconda and Masulipatam; near Parma in Bundelcund, where some of the most magnificent specimens have been found; and extensively on the Mahanuddy and in the vicinity of Ellore. Perhaps the finest and most perfect Indian diamond, in respect to size and colourless transparency, or *water* as it is termed, is the Regent or Pitt diamond. It was found in the Golconda district, and imported into this country by Mr Pitt, governor of Madras, who, after offering it to different royal personages, sold it to the regent of France in 1717. Napoleon placed it in the hilt of his sword of state. It is cut in the form of a brilliant, weighs 136 carats, measures in length 1.243 inches, in breadth 1.777, and in depth .859; and its estimated value is L.125,000. This, however, is by no means the largest known diamond; for though superior in water, it cannot compete in size with that of the Emperor of Russia, which weighs 193 carats, and is about the size of a pigeon's egg. It is said to have been stolen from the eye of an idol by a French soldier, from whom it came into the possession of the Empress Catharine. The diamond of the Great

Mogul, which in its rough state weighed nearly 800 carats, after being reduced by polishing is still 279 carats. The collection at Vienna contains a remarkable pale-yellow coloured diamond; and in the Grüne Gewölbe at Dresden there is a peculiar one of a green tinge. The island of Borneo is the only other eastern locality of diamond; it occurs at Pontiana, and is said to be of superior quality. The Rajah of Mattan possesses one which was found there about a century ago, weighs 367 carats, and is described as of the first water. Up to the commencement of the 18th century, diamonds were wholly derived from India and Borneo. In Brazil, the district of Minas Geraes comprehends, as far as we know, the whole diamond grounds of the American continent. Large stones do not abound there; Mawe mentions one of 120 carats, but they rarely exceed eighteen or twenty. The Emperor of Brazil's celebrated diamond of 1680 carats, though so called, is with pretty good reason believed to be a topaz.

Colourless diamonds of the first water are the most valuable, but very fine stones also present red, blue, and yellow tinges; those of the latter colour are often remarkably brilliant, and are said to possess superior hardness. Their value is calculated in carats consisting of four grains, each carat, however, being = 3.174 grains troy; the price, in proportion to their size, advancing in an extremely rapid ratio. The grinding and cutting of diamonds is entirely done by the hand, and is principally effected by rubbing two of them together. Besides being highly valued as an ornament, this gem is employed for engraving, and for cutting glass; and, in the form of powder, for grinding hard stones, and polishing the diamond itself.

Dr Wollaston observes that the curved surface of the natural diamond is required to give it that clean cutting edge required by glaziers; for when a diamond is formed and polished by a lapidary, all the surfaces are plain surfaces, and the edge or line in which they meet is consequently straight; but in the natural diamond the surfaces being generally curved, the meeting of any two of them presents a curvilinear edge. If the diamond be so placed that the line of the intended cut is a tangent to this edge near to its extremity, and if the two surfaces of the diamond be equally inclined to the surface of the glass, then the conditions necessary for effecting the cut are complied with. If, on the contrary, an attempt be made to cut, with an inclination that deviates from the perpendicular, the glass will be superficially flawed out on that side to which the greater pressure was directed, and a rough white line will be made, but the cut will completely fail. A glazier's diamond, then, requires not only to be set with great accuracy, but to be handled at a particular elevation, in order to produce the necessary incision.

Diamonds have been imitated with great success by the French; their hardness alone distinguishing them from the real gem. For farther accounts of the value and mode of cutting diamonds, see *Encyclopædia Britannica*, seventh edition, article **DIAMOND**.



## TOPAZ.

Prismatic Topaz, *M. and J.* Topas, Phisalit, Picnit oder Schorlartiger Beril, *W.*  
 Topaze, Pycnite, Silice Fluatée Alumineuse, Alumine Fluatée Siliceuse, *H.*

Sp. Gr. 3.4—3.6. H. = 8.0.

Prismatic. FIG. 120. Inclination of *o* to *o* =  $141^{\circ} 7'$ , of *o* to *M* =  $135^{\circ} 27'$ , of *M* to *M* =  $124^{\circ} 19'$ . Opposite terminations of the crystals often differently formed, and prism usually striated longitudinally. *Colour* white, yellow, green, blue. Transparent or translucent. *Lustre* vitreous. *Cleavage* highly perfect, perpendicular to the axis. *Streak* white. According to Berzelius, the different varieties consist of

	<i>Topaz.</i>	<i>Physalite.</i>	<i>Pycnite.</i>
Alumina	57.45	57.74	51.00
Silica	34.24	34.36	38.43
Fluoric acid	7.75	7.77	8.84

It is infusible *per se*, but when strongly heated the faces of crystallization are covered with small blisters, which crack as soon as formed. With borax it melts slowly into a transparent glass. It becomes electric when heated, and is easily excited by friction. When reduced to powder it changes the solution of violets to green.

## OBSERVATIONS.

Topaz is not, like quartz, a component part of any particular rock, but at Schneckenstein in Saxony, and in several parts of Cornwall, it occurs associated with tourmaline, quartz, and lithomarga, producing the mixture named by Werner topaz-rock. Its usual matrix is granite, accompanying beryl, mica, tourmaline, &c., and occasionally with fluor spar, apatite, and tin. The bright-coloured and transparent varieties are particularly named Topaz, the coarser and more opaque being termed Physalite. The district of Cairngorum in Aberdeenshire has produced the largest and most magnificent crystals of topaz. My father's collection contains two from that locality, which are as remarkable for their dimensions and symmetry of form, as for their colour. They present a fine sky-blue, except on the acute edges of the prism, which appear pale brown, a character peculiar to Scotch topazes, and one of which the skilful lapidary takes advantage, in obtaining gems of different hues from the same crystal. Jameson mentions a crystal from this locality which weighed nineteen ounces; the largest in my father's collection only amounts to  $5\frac{1}{2}$  oz. Topazes from this locality, however, are rare in comparison with those from the Uralian and Altai Mountains of Siberia, or the green and blue ones from Kamtschatka. In Brazil they occur either in small

veins or nests imbedded in lithomarga, or forming loose crystals and pebbles, sometimes quite transparent, but generally of a deep yellow colour; and at Mucla in Asia Minor, in distinct well-pronounced crystals, of a pale straw yellow. In smaller individuals, topaz is met with in the tin mines of Schlaggenwald, Zinnwald, and Ehrenfriedersdorf in Bohemia; at Schneckenstein and Eibenstock in Saxony; at St Michael's Mount in Cornwall, and in many other places, along with crystals of tin. In the Mourne Mountains it is found in small limpid crystals, associated with beryl, albite, and mica, in the drusy cavities of granite. Most topazes become electric when heated, a property which few other minerals possess, and which the Siberian variety in particular retains for many hours afterwards. If both terminations are perfect, they present opposite kinds of electricity; and when transparent, this is excited on being slightly rubbed with a silk handkerchief, or even by pressure. Many topazes are interspersed with cavities containing fluids, which have been described by Sir David Brewster, both in the Edinburgh Royal Society's Transactions, and in his own Journal. Crystals of titanium likewise have been observed in the Brazilian specimens. Topaz is used as an ornamental stone, and for that purpose is frequently altered in colour by exposure to heat; the Saxon variety becoming perfectly limpid, while the deep-yellow from Brazil assumes a pale pink or red hue, so closely resembling that of Ballas ruby, that when polished it can only be distinguished by the electricity so easily excited in it by friction. The finest natural stones employed by the lapidary are those from Minas Novas in Brazil, which from their peculiar limpidity are denominated *Goutte d'eau*; they are not very common, but when cut with facets, and set as rings or brooches, frequently pass during day-light for diamonds, which in transparency and brilliancy they closely resemble. Some coarse varieties are pounded and used instead of emery for grinding hard substances.

The *physalite*, or *pyrophyysalite* of Hisinger, is a coarse almost opaque variety of topaz, found occasionally in yellowish-white crystals of considerable dimensions. Its only localities are Finbo and Broddbo, near Fahlun in Sweden; the former a granite quarry, the latter a boulder composed of the same rock, which, from the numerous specimens it afforded to collectors, has been entirely broken up and carried off. The college of mines at Stockholm contains a single well-pronounced crystal from the latter, which weighs 80 pounds. This variety intumesces when heated, whence its name from the Greek.

*Pycnite* used to be considered white schorl, and was thence denominated *schorlite*. It does not occur in distinct single crystals, but consists of thin straight columnar particles, forming masses imbedded in other rocks. Altenberg in Saxony, where it is associated with quartz and mica, is its best known locality. Its specific gravity is considerably higher than that of beryl; and from such minerals as it otherwise resembles it may be distinguished by its infusibility.



## EUCLASE.

Prismatic Emerald, *M.* Euclase, *P.* Euclas, *W.* Euclase, *H.*

Sp. Gr. 2·9—3·2.  $H. = 7·5$ .

Hemi-prismatic. FIG. 121.\* Inclination of *m* to *m*  $114^{\circ} 50'$ . Colour pale mountain-green, passing into blue and white. Transparent, or semi-transparent. Lustre vitreous. Cleavage highly perfect and easily obtained parallel to *h* and a face bevelling the edge *x*. Fracture perfect conchoidal, brilliant. Very brittle and fragile, hence its name. Faces *m* brilliant and free from striæ, all others in the same direction being distinctly streaked. Contains, according to Berzelius, silica 43·22, alumina 30·56, glucina 21·78, oxide of iron 2·22, oxide of tin 0·70.

Strongly heated before the blowpipe, it intumesces and becomes white; and, on the temperature being still farther increased, fuses into a white enamel; with borax it yields a transparent colourless glass. It possesses double refraction, and becomes electric on friction or pressure, a property which it retains for many hours after.

## OBSERVATIONS.

This rare mineral was first brought from Peru; but of late years also from Capao, in the mining district of Villa Rica in Brazil. Its matrix is said to be chloritic slate resting on sandstone; but it generally comes to this country in detached and fractured crystals. The most magnificent specimens of euclase in Britain are those belonging to Mr Rundell. It generally presents an agreeable and uniform colour, is free from flaws, and admits of a good polish; but its extreme fragility renders it useless as an ornamental stone.

## EMERALD.

Rhombohedral Emerald, *M.* Rhomboidal [Emerald, *J.* Beryl, Aquamarine, Emerald, *P.* Smaragd, Beril, *W.* and *L.* Emeraud, *H.*

Sp. Gr. 2·6—2·8.  $H. = 7·5—8·0$ .

Di-rhombohedral. FIG. 44. In six-sided prisms, having their terminal edges occasionally modified. Inclination of *x*

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\* From Levy's drawing of a well-defined pale-green coloured crystal in the cabinet of Mr Heuland. Edin. Phil. Jour. xiv. 129.

to  $M = 119^\circ 53'$ . Colour green, sometimes very brilliant, passing into pale blue, yellow, or white. Transparent or translucent. Lustre vitreous. Streak white. Cleavage parallel to P, less easily obtained parallel to M. Fracture conchoidal and uneven. Surface of the prisms striated parallel to their axis. Contains

	<i>Emerald.</i>	<i>Beryl, Siberia.</i>	<i>Beryl, Broddbo.</i>
Silica	68.50	66.45	68.35
Alumina	15.75	16.75	17.60
Glucina	12.50	15.50	13.13
Oxide of iron	1.00	0.60	0.72
Oxide of tantalum	0.00	0.00	0.27
Oxide of chrome	0.30	0.00	0.00
Lime	0.25 Klap.	0.00 Klap.	0.00 Berz.

Transparent varieties become clouded before the blowpipe; at a high temperature the edges are rounded off, and a vesicular scoria is ultimately produced. With borax it forms a transparent colourless glass.

## OBSERVATIONS.

Emerald and Beryl, though distinguished by some mineralogists, differ only in colour; the former term applying to the rich, deep, emerald-green variety; the latter including all others, whether colourless or not. The emerald, when clear, transparent, and of a tolerable size, is highly valued as a gem, particularly if brilliant and uniform in colour and free from flaws; but in general it is deteriorated by numerous strata of cavities containing air or fluid. Its finest crystals occur in a vein of magnesian limestone, which traverses a hornblende rock at Muso, near Santa Fé de Bogota in Granada. The Duke of Devonshire possesses a perfect hexagonal prism from this locality, which exceeds two inches in length, and measures across its three diameters  $2\frac{1}{4}$ ,  $2\frac{1}{8}$ ,  $1\frac{7}{8}$ , inches; it weighs eight ounces, eighteen dwts.; and though only partially fit for jewellery, from the numerous flaws it contains, was lately valued at 150 guineas. My father's collection contains a perfect crystal of the same form and description, which measures rather more than an inch in each direction; the finest cut emerald, however, in Britain, is said to be that in the possession of Mr Hope of London. It weighs no less than six ounces, is perfect in colour and transparency, and cost L.500. Less distinct varieties occur at Mount Zalora in Upper Egypt, the only locality of emerald with which the ancients are believed to have been acquainted; at Cangarjum, in the district of Coimbetoor, in Hindostan; and imbedded in mica slate in the Heubach valley, Pinzgau district, Saltzburg.

All varieties of this species not of an emerald-green colour are denominated beryl; and such of them as are clear, transparent, and exhibit



brilliant shades of sky-blue or mountain-green, are known among lapidaries under the name of *aquamarine*, or precious beryl. The most magnificent specimen of this variety with which mineralogists are acquainted is the aquamarine belonging to Don Pedro, which is nearly as large as, and somewhat resembles in form, the head of a calf; it weighs 225 ounces troy, or more than  $18\frac{1}{2}$  pounds. One side exhibits slight indications of crystalline structure; but it is otherwise quite water-worn. Its surface is consequently dull, though the mass appears clear and transparent, presents a fine pale bottle-green colour, and, large as it is, has not a flaw.

Large hexagonal pale-green coloured prisms of beryl are met with in the granitic district of Nertschinsk, and in the Uralian and Altai ranges of Siberia. They have been found exceeding a foot in length, and, when divested of their matrix, appear deeply striated longitudinally. Acworth in New Hampshire, U. S., has latterly also become celebrated for its beryls. In Silliman's Journal, xvii. 355, mention is made of a crystal from that vicinity, which measured four feet in length, and five and a half inches across its lateral faces, and which weighed 238 lbs.: this gigantic specimen is described as of a bluish-green colour at one end, passing into dull green and yellow at the other, its faces possessing considerable lustre, and being free from longitudinal striæ. Beautiful specimens occur in granite, associated with topaz, felspar, black quartz and mica, at the Morne Mountains, county Down. Their crystals are occasionally two or three inches in length, and have a peculiar pale blue colour. At Cairngorum in Aberdeenshire, beryl is found under similar circumstances, though less frequently. A coarse nearly opaque variety occurs, both crystallized and in large masses, near Limoges in France, and imbedded in granite at Finbo and Broddbo near Fahlun in Sweden; and others at Bodenmais and Rabenstein in Bavaria, and elsewhere. From Hindostan some fine pale green beryls have lately been imported; they were found in the district of Ghellan, thirty miles southwest of Madras.

The fine green colour of Peruvian emerald is attributed to a minute portion of chrome; while beryl owes its mountain-green and yellow tinges to an admixture of oxide of iron. Both varieties are great embellishments to the cabinets of collectors, and afford ample scope to the jeweller for the exercise of his taste.

### IOLITE.

Prismatic Quartz, *M.* Prismato-Rhomboidal Quartz, or Iolite, *J.* Dichroite, *P.* Pe-  
liom, *W.* Cordierit, *L.* Cordierite, *H.*

Sp. Gr. 2.5—2.6. H. = 7.0—7.5.

Prismatic. FIG. 122. In prisms of twelve sides. Inclination of M to M over *e* =  $120^\circ$ , of M to P =  $90^\circ$ . Colour ge-

nerally dark blue, black, or brown. Translucent, and of a deep blue, when viewed in the direction of the axis ; transparent, and brownish-yellow or smoke-grey, when held perpendicular to it. *Lustre* vitreous, inclining to resinous. *Streak* white. *Cleavage* parallel to P and c, indistinct. *Fracture* imperfect conchoidal. Surface of the crystals generally rough and dull.

Contains

Silica	48.54	42.6	49.95
Alumina	31.73	34.4	32.88
Magnesia	11.30	5.8	10.45
Oxide of iron	5.69	1.5	5.00
Ox. of mangan.	0.70	1.7	0.03
Water or loss	1.65	0.0	0.00
Lime	0.00	Strom. 1.7 Gmelin.	0.00 Bonsdorff.

Its chemical formula indicates 49.93 silica, 32.60 alumina, 10.32 magnesia, and 5.0 oxide of iron. Strongly urged before the blowpipe, it fuses on the edges into a blue transparent glass, and with borax melts slowly into a diaphanous globule. It is not acted upon by acids.

OBSERVATIONS.

Cordier, who distinguished and described this mineral, named it *dichroite*, from the peculiar changes of colour he observed in it. *Steinheilite*, *pelion*, and *hard fahlunite*, are names given by other mineralogists to the same substance ; the last, however, referring particularly to a reddish-brown massive variety, whose aspect is more resinous than the others, from the mines of Eric Matts and Nafversberg, near Fahlun in Sweden. *Iolite* occurs at Bodenmais in Bavaria, occasionally in distinct crystals, but generally massive, and associated with magnetic pyrites ; in very large individuals engaged in quartz, at Ujorsdlersoak in Greenland ; imbedded in granite with felspar and garnet at Cape de Gatte in Spain ; and in other primitive rocks at Arendal in Norway, Tunaberg in Sweden, Finland, Siberia, and India.

The *sapphire d'eau* of jewellers, a transparent variety of this species, occurs principally in small rolled masses in Ceylon ; its blue colour is very intense, but in lustre and hardness it is inferior to sapphire ; and its specific gravity is much less. When cut it also presents the phenomenon of double colours, and though occasionally used in jewellery, is of inferior value as an ornamental stone.



## QUARTZ.

Rhombohedral Quartz, *M.* Rhomboidal Quartz, Floatstone or Spongiform Quartz, *J.* Quartz, Cats' Eye, Flint, Calcedony, Agate, Jasper, Hornstone, *P.* Eisenkiesel, Berg-crystal, Hornstein, Kieselschiefer, Feuerstein, Krisopras, Plasma, Heliotrop, Kalzedon, Jaspis, Katzenauge, Faserkiesel, Schwinstein, Schwimmkiesel *of the Germans.*

Sp. Gr. 2.5—2.7. H. = 7.0.

Rhombohedral. Fig. 123. Inclination of *P* to *z* =  $133^{\circ} 44'$ , of *P* or *z* to *r* =  $141^{\circ} 47'$ . Prevalent colour white. Transparent or translucent; when impure, commonly opaque. *Lustre* vitreous, inclining in some varieties to resinous. *Streak* white. *Cleavage*\* parallel both to prismatic and pyramidal faces, though imperfect, and interrupted by conchoidal fracture; in amethyst the fracture presents numerous very delicate undulated lines, analogous to those on the palm of the hand. Perfect varieties consist of pure silica, corresponding to the chemical formula for 49.70 silicium, and 50.30 oxygen; several of them contain small quantities of alumina, lime, oxide of iron, &c. Quartz, like pure silex, is infusible *per se* before the blow-pipe, but with soda effervesces, and melts readily into a clear globule. When compact it yields sparks with steel; and if two pieces be rubbed together, a phosphorescent light and a peculiar empyreumatic odour is emitted.

## OBSERVATIONS.

There are few mineral species which occur more frequently, or are more universally diffused, than quartz, being met with in rocks of every era, from the granite of primitive mountains to the recent scoria of active volcanoes; and there is not perhaps one whose varieties differ so much in external appearance, or which at first sight so slightly resemble each other. The consequence is, that mineralogists have subdivided it into numerous species, and described as particular minerals, what, upon a closer examination of their natural historical properties, are evidently mere varieties of the same.

Quartz is understood to designate the simple or crystallized varieties,

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\* This, as in many other minerals, is most easily obtained by heating the specimen, and then immersing it in cold water.

and such as possess a vitreous fracture. It includes the following subspecies. *Amethyst*, which is not now limited to violet or amethystine blue colours, but refers to all those, whether white, yellow, or green, which present, when fractured, the peculiar undulated structure described by Sir David Brewster. The finest blue amethysts, deriving their colour from a minute admixture of iron and manganese, come from Siberia, India, Ceylon, and Persia, where they occur both coating the cavities of geodes, and as pebbles. Of inferior transparency and hue they are met with in Transylvania, Hungary, Saxony, and the Hartz; also in large crystalline groups in the vicinity of Cork, and at the island of May, in Ireland. White and yellow varieties come from Brazil, and, when cut, are occasionally sold for topaz. The colour of amethyst is often irregularly diffused, and is entirely lost if the specimen be heated; but when of a good size, deep uniform tinge, and considerably transparent, it forms a gem of great beauty. Like most other stones, however, it is less brilliant by candle-light, and at all times appears to best advantage when surrounded with pearls and set in gold.

*Rock-crystal* comprehends the colourless, transparent, highly crystalline varieties, splendid specimens of which are found in Switzerland, Savoy, Dauphiné, and Piedmont, forming drusy cavities in mica-slate; also in Madagascar, Ceylon, and Brazil. Beautifully limpid crystals occur in the primitive marble of Carrara, and very brilliant specimens at Cape Diamond, near Quebec. When perfectly pure it is cut into lenses, or *pebbles* as they are termed, for spectacles and other optical purposes; and when of sufficient size is formed into vases and chandelier ornaments. At Briançon a manufactory formerly existed, where the rock crystal of Dauphiné was employed for these purposes. When uncrystallized it bears much resemblance to glass, but may be distinguished by its greater hardness, and from flint-glass by its inferior weight; moreover, the cavities in quartz are invariably disposed within the same or parallel planes, while in glass they are dispersed throughout the mass without reference to internal structure. As articles of jewellery, the wine-yellow and clove-brown varieties are most esteemed. These are denominated *Smoky Quartz*, and are met with in Bohemia, Pennsylvania, and elsewhere. The Scottish *Cairngorum* is another, exhibiting several bright tints of these colours, and fetching occasionally very high prices. One crystal, brought to Edinburgh some years ago, was purchased by Mr Sanderson the lapidary, who cut it into nearly £400 worth of ornamental stones.

*Rose or Milk Quartz* is confined to translucent rose-red and milk-white massive kinds. It takes a fine polish, and, when the colour, which is believed to arise from a slight admixture of manganese, is good, forms beautiful snuff-boxes, clasps, &c. De Dree's collection contained a perfect vase of rose-quartz nine inches in height. Its principal locality is a vein of manganese traversing the granite of Rabenstein near Zwiesel in Bavaria; but it is known in Finland, and forms also a large rock near Connecticut, U. S.



*Prase* derives its dark leek-green colour from an admixture of amphibole. It is only met with massive, and that principally in the iron mines of Breitenbrunn near Schwartzenberg in Saxony.

*Common Quartz* comprehends all that are not included in the above subspecies. It is a most abundant variety, forming veins in primitive and transition rocks; and in South America was observed by Humboldt in mountain masses or beds many hundred feet in thickness. It varies as much in colour as it does in translucency and appearance.

When the compound varieties of quartz possess a fine texture, *hornstone* and *flint* are produced. These always occur massive, are translucent on the edges, and have either a dull splintery, or glimmering and somewhat conchoidal fracture. Splintery hornstone produces the remarkable pseudomorphic crystals from Schneeberg in Saxony, and is met with also, forming veins in Hungary, beds in Norway, and spheroidal masses in the limestone of the Tyrol. Conchoidal hornstone is brought from the isle of Cyprus, Saxony, and Bohemia. *Flinty slate* much resembles hornstone, but exhibits an imperfect slaty fracture, and various dingy grey colours; it occurs in beds and boulders in Bohemia, Silesia, and Hungary. *Lydian stone* is closely allied to it, possessing an even, glimmering fracture, and a greyish-black colour.

*Flint*, a compound variety, like the preceding, is translucent on the edges, and presents a perfect, flat conchoidal, glimmering fracture: it is rarely laminated, and may therefore be broken with equal facility in any direction; a property of which Europeans take advantage for the manufacture of gun flints, and the South Sea Islanders, equally with the ancients, for making arrow heads, axes, and other weapons. It is common in the chalk formation of England, France, and the north of Ireland; occasionally enclosing alcyonia, echini, and other fossil remains.

*Floatstone*, or spongiform quartz, the quartz nectique of Haüy, consists of numerous minute white or grey crystals, has a spongy or porous texture, and, as its name indicates, possesses the property of swimming on water, at least until the air contained in its numerous cavities is displaced. It occurs in the chalk formation of Menil Montant near Paris, and in some of the Cornish mines, but under different forms. It contains, according to Vauquelin, 98 silica, and 2 carbonate of lime; but, on taking it into the hand, its extreme lightness would lead one to expect less ponderous constituents.

When this species occurs in reniform and stalactitic masses, and has an almost impalpable structure, the different varieties of *Calcedony* are produced. These derive their name from the ancient locality of Calcedon or Chalcedon in Asia Minor, and, according to their colour, are distinguished into Common Calcedony and Carnelian, the former comprehending such as present grey and less bright tints, while the latter refers to red varieties. Magnificent specimens of calcedony are found in the amygdaloids of Iceland and the Faroe Islands; at Huttenberg and Loben in Carinthia, in Hungary, and in many of the Western Isles. Trevascus

mine in Cornwall has produced some extremely delicate stalactitic masses, and many beautiful varieties come from India and Siberia. The small blue hexahedral crystals from Tresztyan in Transylvania, though in fact more nearly allied to quartz, are enumerated with this variety, probably because there exist certain calcedonies, particularly in Cornwall, which present the same colour; they are certainly pseudomorphous, and probably derive their form from fluor.

*Carnelians* and *agates* generally form nodules in amygdaloidal and trap rocks. Of these, the largest solid masses are found in Arabia, India, Surinam, and Saxony; smaller and less perfect ones in Perthshire and other parts of Scotland. The interior zigzag parallel lines of some agates, when sliced and polished, bear considerable resemblance to the plan of a modern fortification, hence the name *fortification agate*. Translucent calcedony, containing dark outlines of arborisation, like vegetable filaments, is called *Mocha stone*, from its Arabian locality, or where at least it is principally known. These curious appearances have given rise to numerous conjectures, being ascribed by some to deposits of iron or manganese, by others as arising from fossil cryptogamous plants. *Moss agate* contains variously-coloured vegetable ramifications, and is occasionally traversed with veins of red jasper. Most oriental carnelians are originally dark-grey, and obtain their fine red hue artificially, being exposed for some weeks to the solar rays, and then subjected to heat in earthen pots. Yellow carnelian is well known to lapidaries under the title of *sarde*. The *onyx* presents several distinct shades of colour disposed in parallel bands, and is that variety of agate specially used in forming cameos. Of these, the most celebrated are of very ancient date; the Mantuan vase at Brunswick, for instance, which consists of one stone cut into the form of a cream pot, about seven inches high by two and a half broad; it has a brown ground, with yellow and white groups of raised figures, representing Ceres and Triptolemus in search of Proserpine; it is polished inside, and in some parts does not exceed a line in thickness. The apotheosis of Augustus, an onyx of four bands, measuring eleven inches by nine, and believed to be the largest in existence; and that representing the apotheosis of Ptolemy on one side, and the head of Medusa on the reverse, preserved in the Museo Borbonico at Naples, are splendid specimens of the same.

When massive, and exhibiting a thin, strongly coherent columnar composition, *fibrous quartz* is formed; and when this structure is nearly imperceptible, and the stone, on being cut *en cabochon*, presents a peculiar opalescent streak of light, *cat's-eye* is produced, the rays of light being, in this case, reflected from the silky surface of the filaments of asbestos, with which the mineral is traversed. Cat's-eye is usually greenish-grey, but occasionally presents yellow, red, and brown colours, all of them inclining to grey, and sometimes even nearly black. Specimens of fibrous quartz occur in the Hartz; cat's-eye in Ceylon and on the coast of Malabar.



*Chrysoprase*, consisting of small granular particles, is translucent, massive, and coloured apple-green by an admixture of about one per cent. of nickel. It is met with in considerable quantities at Kosemutz in Silesia, and at New Fane in Vermont, North America, in both places in serpentine. *Avanturine* is quartz including small scales of mica, which, when polished, present a shining spangle-like appearance. Its base is usually grey, brown, or reddish, as in the variety from Cape de Gatte in Spain; and sometimes, as in India, it presents a beautiful green tint. *Plasma* is an unusually transparent kind of calcedony, coloured leek-green, or almost grass-green, by some substance not yet exactly ascertained. It occurs in India and China, and is occasionally brought to this country in the shape of beads and other ornaments; some fine specimens have been picked up among the ruins of Rome, but whence derived is quite conjectural. *Heliotrope* is likewise a calcedony, mixed with and coloured by green earth, and containing spots of yellow or blood-red Jasper. It has hence obtained the name of *bloodstone*, and is found in Bucharina, Tartary, Siberia, and the island of Rum in the Hebrides. The *Iron flint*, *Eisenkiesel*, or *Ferruginous quartz* of Phillips, contains about five per cent. of iron, and occurs principally in the iron-stone veins of Saxony, Bohemia, Hungary, &c. If clay also enters into the mixture, and thereby renders it opaque, various *jaspers* are formed, of which the striped jasper from Siberia, Saxony, and Devonshire is distinguished on account of its ribbon-like delineations; the Egyptian jasper by its red and brown colours and peculiar globular structure, arising no doubt from its formation like that of agate in the hollows of amygdaloid.

It would be difficult and of little avail to enumerate farther the varieties and subspecies into which this mineral has been distinguished; suffice it to say, that common quartz enters into the composition of most primary rocks, as granite, gneiss, mica-slate, &c. among which it also forms beds by itself, while calcedony, carnelian, and agate are met with principally in the vesicular cavities of amygdaloidal rocks; and jasper forming extensive veins both in the primary and transition series. Sandstone may also be considered as almost entirely composed of quartz, and even the minute particles of fine sand are nothing else than common quartz in a state of disintegration. In some places, as on the coast of Norfolk, and at Alum Bay in the Isle of Wight, the sand is perfectly white, and is extensively used in manufacturing glass. Near Villa Rica in Brazil, sandstone occurs in thin strata, which are remarkable for their flexibility, a property apparently arising from small scales of mica disposed throughout its mass.

Quartz crystals sometimes occur of very large size; a group in the museum of the university at Naples weighs nearly half a ton; another, belonging to Sig. Raffelli of Milan, is three feet and a quarter in length by five and a half in circumference, and is estimated at 870 lbs.; and a third in Paris is three feet in diameter, and weighs about 8 cwt. Both the surface and interior of rock crystals present sometimes beautiful iri-

descences, which, when superficial, arise from a slight coating of metallic oxide, but when internal, are caused by the refraction of light in numerous fissures; this appearance may be produced artificially by heating the crystal nearly to redness, and then plunging it into hot water. Others again are remarkable for the numerous objects, both solid and fluid, which they contain, as amianthus, actinolite, oxide of iron, titanium, bitumen, anthracite, tourmaline, air, and water. (Brewster in Royal Soc. Trans. Edin. vol. x.) The fluids, in these, only partially fill their respective cavities, so that the globule of air or vapour which occupies the remaining space, moves backwards and forwards as in a spirit level. Jacobson of Copenhagen possesses a geode of quartz one inch and quarter long, which contains at least half a cubic inch of fluid; and Brewster mentions (Jour. x. 370) a specimen of calcedony with a cavity seven tenths of an inch long, which was half full of fluid. The amygdaloidal pebbles of the Euganean Hills are well known; and in the crystals commonly brought from Quebec, globules of water are of frequent occurrence. I possess a fragment of amethyst, which has four crystalline cavities enclosing the peculiar fluid described by Sir D. Brewster. The largest of these is nearly half an inch in length, of which the vacuity is about one fourth; at a temperature of  $83^{\circ}$  the fluid dilates and entirely fills all the cavities; and as it re-appears on cooling, an apparent ebullition is manifested. The cavity of another specimen, a crystal from Quebec, contains a small group of calc-spar which moves through the fluid upon turning the specimen. In general, however, as ascertained by the experiments of Sir Humphry Davy, the fluid contents of rock crystal consist of water with very minute quantities of saline impregnations; and the elastic fluid is azote. On the other hand, silica is held in solution by some waters, as that of the Gyser in Iceland, the evaporated ingredients of which, according to Dr Black's experiments (Royal Soc. Trans. Edin. vol. III.), afforded no less than fifty-four per cent. of siliceous earth. This is supposed to be retained in solution by means of an alkali, assisted by the elevated temperature of the water itself, and, it is well known, is deposited around the springs in the form of siliceous sinter.

The simple crystalline forms of quartz are by no means numerous, but they are apparently multiplied to an indefinite extent by the accidental anomalies which arise from the circumstance that its faces, while they invariably preserve their mutual incidences, vary in their relative distance from the centre. Sometimes a pyramidal face is enlarged into the base of an apparently oblique prism; sometimes this enlargement is so considerable on opposite planes of the prism, that tabular-shaped crystals like those of barytes are produced; in fact, from distortions of this kind, forms are occasionally met with in quartz whose true position it is difficult to ascertain. These irregularities are common in limpid and transparent crystals; symmetry and perfection of form appertaining to certain opaque and impure varieties, particularly that from Compostello in Spain,



whose crystals are frequently as regular as if produced by the art of the lapidary.

Another interesting peculiarity of quartz is its frequent occurrence in pseudomorphic crystals. At Schneeberg in Saxony it assumes the form of various calc-spars; at Beeralstone in Devonshire that of certain fluors; at Mont Martre near Paris of lenticular gypsum, &c. The *Haytorite* from Devonshire is another variety of pseudomorphic quartz, but the mineral whose form it assumes has not been ascertained; some mineralogists suppose datholite, others sphene; and it is surprising to what an extent the discussion of this point has been carried. (See Ann. of Phil. Jan. 1827; and Brewster's Journal, vol. vi.) Many of its crystals are hollow and thin, their inner surface being mamillated like calcedony.

Such varieties of quartz as are transparent, or present fine colours and delineations, are highly prized for ornamental purposes; the amethyst, carnelian, onyx, cat's-eye, and agate, being occasionally coloured artificially with that view. The Scotch pebble, for instance, consisting of more or less porous concentric circles, is boiled in oil, and then in sulphuric acid, which carbonizes the oil imbibed by the more porous parts, colours them black, and thus produces an onyx-like appearance. When cut and polished, some of the crystalline varieties may be mistaken for transparent Brazilian topaz, ruby, or sapphire, but are inferior to all of those stones in hardness, and to most of them in lustre. In Germany large agates are made into cups, plates, mortars for chemical purposes, &c. The royal collection at Dresden contains a table service of German agate; and in the imperial cabinet at Vienna there is an oval dish, consisting of one piece of the same substance, which measures twenty-two inches in length. Jasper, in the same way, is frequently formed into vases, boxes, knife-handles, and plates, producing, from the brilliancy of its polish and fine colour, ornamental stones of very great beauty; it is a good material for engraving upon, and is extensively employed in the manufacture of Florentine mosaics. Quartz is highly useful in the formation of glass and porcelain; as a component in the smelting of several kinds of ores, particularly copper, and in other metallurgical operations. In solid masses it is used for buildings; when in small particles and mixed with slaked lime, it forms mortar; and when in the state of flint, is applied to the well-known purpose of gun-locks.

*Porcelain jasper* is considered by some mineralogists as a variety of this species. It is, however, merely clay indurated by the action of fire; and, as it melts before the blowpipe into a semi-transparent enamel, is totally distinct from quartz. It is compact and massive, presents sometimes a slaty structure, with a vitreous uneven conchoidal fracture, and either a bluish-grey or light-fawn colour. Its principal locality is the neighbourhood of Carlsbad in Bohemia.

## OPAL.

Uncleavable Quartz, *M.* Hyalite, Muller's Glass, Opal, Hydrophane,<sup>5</sup> Menilite, Cacholong, Siliceous Sinter, *P.* Opal, Hialith, Opaljaspis, *W.* Eisenopal, *Haus.* Quartz Hyalin Concretionné, Quartz Résinite, *H.*

Sp. Gr. 1.9—2.2. H. = 5.5—6.5.

Uncrystallised. *Colour* white, yellow, red, brown, green, grey, generally pale; dark colours arising from foreign admixture. Transparent or translucent, occasionally opaque when the colours are dark. *Lustre* vitreous, inclining sometimes to resinous. *Streak* white. No cleavage. *Fracture* conchoidal. Some varieties have a lively play of light, a property, however, which they lose when heated; others exhibit different colours by refracted and reflected light. They consist of

	<i>Hyalite.</i>	<i>Precious Opal.</i>	<i>Menilite.</i>
Silica	92.00	90.0	85.5
Water	6.33	10.0	11.0

The last also contains, like several others, small portions of iron, alumina, lime, and carbon. Before the blowpipe it is infusible, but decrepitates, gives out water, and becomes opaque.

It is easily distinguished from quartz by its inferior hardness and specific gravity, the latter, in opal, never exceeding 2.2, while in quartz it is always above 2.5. Neither does opal present the appearance of regular forms; nor, though it affords the same phosphorescence as quartz when two pieces are rubbed together, does it yield sparks with steel as that mineral does.

## OBSERVATIONS.

Haüy and Berzelius united this with the preceding species; Werner, on the contrary, not only distinguished it from quartz, but separated it into a number of sub-species, an arrangement which has been adopted by most other mineralogists. *Precious opal* includes such specimens as exhibit the peculiar brilliant display of prismatic colours. These principally occur, imbedded in porphyry, at Czerventza near Cashau in Hungary, and at Gracias a Dios in the province of Honduras in America. *Wood opal* is sufficiently distinguished by its ligneous structure and semi-transparency, and is found occasionally forming large trees in the pumice conglomerates of Saiba near Neusohl, and Jasztraba near Kremnitz in Hungary, in many districts of Transylvania and Bohemia, in Faroe and other trap countries. In the Liverpool Museum there is a magnificent specimen of this variety, weighing between 200 and 300 lbs., from the river Derwent, forty miles above Hobart Town in Van Diemen's Land, where it is said to occur in vast trunks. These opalized woods present many varieties of colour, and frequently the same piece affords totally



different appearances in different parts. *Fire opal* or *girasol* of the French, possesses bright hyacinth-red and yellow tints, and is brought from Zimapan in Mexico, and the Faroe Islands. *Common* and *semi-opal* are devoid of the fine play of colours, and are distinguished from one another by their different degrees of transparency and lustre, and by the perfection of their conchoidal fracture. These varieties are more plentiful in Hungary, which may, with propriety, be termed the native country of opals, than perhaps in any other quarter of the globe. They occur there in short irregular beds traversing porphyry; in Faroe occupying the cavities of amygdaloidal rocks; in Iceland; at the Giant's Causeway; and among the Hebrides.

*Hyalite* or *Muller's Glass* appears in small reniform, botryoidal, and sometimes stalactitic shapes, and either of a white colour or transparent. It occurs in amygdaloid near Frankfort, at Schemnitz in Hungary, and imbedded in clinkstone at Waltsch and other places in Bohemia. *Menilite* is generally brown and opaque; it occurs in compact reniform masses, presenting occasionally a slaty structure, imbedded in adhesive slate at Menil Montant near Paris. *Opal Jasper*, or *Ferruginous Opal*, bears the same relation to this species as common jasper does to the preceding. It contains sometimes as much as 47 per cent. of oxide of iron, and is occasionally used as an ore of that metal. It is found in the same localities as common opal in Hungary and Transylvania, particularly in the altered pumice of trachytic conglomerates, among which it forms masses like flints in chalk; also at Dominica and St Helena. *Hydrophane* is merely a variety of opal devoid of transparency, but assuming it when immersed in water or any other transparent fluid; emitting at same time numerous globules of air, and becoming considerably heavier. This property is supposed to arise from long exposure to the atmosphere, as the Hungarian hydrophane, at least, is always observed near the surface, while the finest opals lie considerably deeper. *Cacholong* is nearly opaque; it adheres to the tongue, and contains a small portion of alumina. It is closely allied to, and generally associated with hydrophane, deriving its name (it is said) from the river Cach in Bucharra, on whose banks it occurs in loose masses. The Giant's Causeway produces small masses resembling mountain-cork, which are quite opaque until immersed in water, when they dilate and become translucent. *Siliceous Sinter* is a deposit from hot springs, particularly those of the Geyser of Iceland, where it forms stalactitical, fibrous, porous, "cauliflower like," and sometimes even compact, incrustations. *Pearl sinter* or *fiorite* is met with in the cavities of volcanic tuffa, in globular and botryoidal masses, which are extremely smooth and shining, and have a pearly lustre.

The phenomenon of the play of colours in precious opal has not been satisfactorily explained. Sir David Brewster concludes, from numerous experiments, that it depends upon openings in the interior of the mass, which are not fissures, but possess an uniform shape; and that in some varieties of hydrophane the openings are so large that these colours can-

not longer be reflected by the included air, and are not visible until they are filled with water, or some fluid possessing high refractive powers. If such be the case, these openings must be extremely minute, for the play of colours is as observable in the smallest microscopic fragments as in larger pieces. Precious opal therefore owes its beauty to what are really imperfections: it is considered a gem, and when large, pure, and possessing vivid colours, is highly prized by the lapidary. It is rarely cut with facets, the convex form being more suitable to its play of colour; and its extreme brittleness preventing the free use of lapidaries' tools. The largest known mass is that in the imperial cabinet of Vienna. It is about the size of a man's fist, and weighs 17 ounces, but contains numerous fissures, and is not entirely disengaged from the matrix.

In the Birman empire, as also in many parts of Hindostan and South America, there is often met with, in the hollows of certain bamboos, a white milky translucent substance, which much resembles, and presents all the physical qualities of, semi-opal. It exists originally in the state of a transparent fluid, which acquires by degrees the consistency of a mucilage resembling honey, and is afterwards converted by gradual induration into a white solid, termed by the natives *tabasheer*. It is sometimes placed in the cabinets of collectors, under the name of *vegetable opal*.

### OBSIDIAN.

Empyrodox Quartz, *M.* Indivisible Quartz, Fusible Quartz, *J.* Pearlstone, Pitchstone, Pumice, Obsidian, *P.* Obsidian, Pechstein, Perlstein, Bimstein, *of the Germans.* Petrosilex résinite. Lave vitreuse obsidienne, perlée, pumicée. Feldspath résinite, *H.*

Sp. Gr. 2·2—2·4. H. = 6·0 = 7·0.

Devoid of regular form or cleavage. Colour black, brown, red, yellow, green, grey, white. Faintly translucent. Lustre vitreous or resinous. Streak white. Fracture sometimes perfect conchoidal, sometimes scarcely visible.

The different varieties have yielded

	<i>Obsidian.</i>	<i>Pitchstone.</i>	<i>Pearlstone.</i>	<i>Pumice.</i>
Silica	72·0	73·00	75·25	77·50
Alumina	12·5	14·50	12·00	17·50
Potash } Soda }	10·0	{ 0·00 1·75	{ 4·50 0·00 }	3·00
Ox. of iron and mangan. }	2·0	1·10	1·60	1·75
Lime	0·0	1·00	0·50	0·00
Water and Bitumen }	0·0	8·50	4·50	0·00



Before the blowpipe these melt with more or less facility, according to the fusibility of their ingredients, either into a vesicular glass, or a white enamel. Their inferior specific gravity and hardness distinguish them from quartz.

## OBSERVATIONS.

Though these varieties present very different aspects, they are intimately connected by transitions. *Obsidian* is distinguished by its black colour, its vitreous lustre, and perfect conchoidal fracture, and, from its close resemblance to bottle glass, has received the trivial name of *volcanic glass*. Iceland and the Lipari Islands are the most celebrated localities of obsidian; though some remarkable varieties are likewise found in Ascension, Teneriffe, and many of the South Sea Islands, Siberia, and Mexico. The specimens from Iceland are almost opaque, exhibiting a brownish tinge only on the thinnest edges, while those from Lipari are more transparent, and of a greyish colour. In Lipari the large continuous tracts of obsidian form the lower strata, while those varieties of a more pumaceous aspect occur invariably at a higher level. The purest, blackest, and most beautiful specimens, however, form imbedded nodules in the pumice at a great height, in masses from two inches to as many feet in diameter. Obsidian is frequently interspersed with small white opaque globules, which, being formed in parallel lines, give it a stratified appearance; and some of the Lipari varieties closely resemble certain glass-house slags.

When conchoidal fracture is less perfect, and it becomes uneven or splintery, the lustre at same time diminishing and passing into resinous, *pitch stone* is produced, a name derived from the striking resemblance it frequently bears to pitch. Of this variety, the hills around the valley of Tribisch, near Meissen in Saxony, and certain of those in the Isle of Arran, where it forms extensive veins in granite, are the best known localities. It is found in a vein traversing granite near Newry, County Down, in smooth lamellar concretions of a mountain- or leek-green colour. The Hon. George Knox of Dublin, in his observations on this mineral, states, that on being exposed to a high temperature it loses its bitumen and water, and is converted in every respect into a light substance resembling pumice. Among others, he mentions that the Arran pitchstone contains two per cent. of bitumen. (Phil. Trans. for 1823.) The colours of pitchstone are principally brown, green, or red, and it presents frequent transitions into obsidian on the one side, and when composed of roundish masses imbedded in a vesicular matrix, into *pearl stone* on the other. These round pearly-like globules consist of concentric coats, and not unfrequently include a grain of obsidian. They form extensive beds in Hungary, between Tokay and Keresztur, at Glashutte, near Schemnitz, and elsewhere; also in Iceland, Spain, and Mexico.

*Pumice* is closely connected with obsidian, being frequently interstratified with it, and at Lipari exhibiting every intervening stage of tran-

sition. At this locality it is sometimes compact, and then its lightness and freedom from humidity render it a peculiarly suitable building material; sometimes it is fibrous, its filaments having a peculiarly silky aspect; and frequently it presents the most delicate glassy texture, breaking into a million of atoms on the smallest stroke with the hammer. At the northern extremity of the island of Lipari it forms a hill 800 or 1000 feet in height, which from its peculiar whiteness and scanty herbage is termed *Il Campo Bianco*. This and the isles of Ponza are the great deposits of the pumice known in commerce, and from these localities it is quarried and exported in large quantities; for though by no means an uncommon mineral in other volcanic countries, as in Hungary, the neighbourhood of Andernach on the Rhine, Teneriffe, Vesuvius, and Ischia, it occurs at these localities in small cinder-like masses, and is neither so massive nor so pure as at Lipari. It was by a shower of pumaceous ashes that Pompeii was overwhelmed, and in this respect its destruction differed from that of Herculaneum, which, it is well known, was first enveloped in hot mud, and then buried under a stream of lava. From its light cineritious structure, and numerous vesicular cavities, pumice is buoyant for some time on the surface of water; and from this cause is found in considerable quantities on the shores of Italy and Sicily.

All these varieties contain imbedded crystals and grains of felspar and mica, particularly those from Ischia, which are characterized by their large and frequently well-defined crystals of glassy felspar. Certain obsidians occasionally also, include specks of olivine, and traces of other volcanic minerals. Obsidian is still used by the Mexicans and some of the South Sea Islanders for knives and weapons; the ancients employed it, when polished, by way of mirrors; and some kinds when cut convex present a fine olive green opalescent appearance, which renders it valuable to the lapidary. Pumice yields a well-known grinding and polishing material, and is well adapted for filtering stones.

*Marekanite* is a peculiar pearl-grey translucent variety from Marekan in Kamtschatka; and a remarkably transparent bottle-green obsidian occurs in detached masses at Moldanthein in Bohemia.

### ISOPYRE.

Isopyric Quartz, *Haid.* Edin. New Phil. Jour. III. 265.

Sp. Gr. 2.9—3.0. H. = 6.0—6.5.

Massive. *Colour* greyish- or velvet-black, occasionally dotted with red as in heliotrope. Opaque or faintly translucent on its thinnest edges, with a dark liver-brown tint. Brittle. *Lustre* vitreous. *Cleavage* not perceptible. *Fracture* flat conchoidal, highly perfect when the mineral is pure. Acts slightly on the



magnetic needle. Contains silica 47.09, alumina 13.91, peroxide of iron 20.07, lime 15.43, peroxide of copper 1.94.—Turner. It fuses before the blowpipe without emitting any gaseous matter. Acids act upon it with difficulty, but it is easily and completely decomposed by alkaline carbonates.

## OBSERVATIONS.

This mineral much resembles obsidian, but was distinguished by Haidinger in consequence of its fainter and less vitreous lustre. It is perfectly black, and forms compact masses occasionally two inches in diameter, in the granite of St Just near Penzance, where it occurs associated with tin and tourmaline. Breithaupt's *Trachylite* (Edin. New Phil. Jour. i. 364) appears to be the same mineral. Its specific gravity is stated somewhat lower, but in other respects it is identical. It forms small masses in basalt and wacke, at Säsebühl near Göttingen.

## AXINITE.

Prismatic Axinite, M. Axinite, P. H. &c.

Sp. Gr. 3.0—3.5. H. = 6.5—7.0.

Hemi-prismatic. FIG. 124. In flat oblique rhomboidal prisms, whose edges are remarkably sharp. Inclination of P to  $u = 135^\circ 10'$ , of P to  $r = 134^\circ 40'$ , of  $u$  to  $r = 115^\circ 17'$ . Colour clove-brown, inclining to plumb-blue and pearl-grey; occasionally green from an admixture of chlorite. Transparent or translucent, sometimes only on the edges. Lustre highly vitreous. Streak white. Cleavage indistinct and interrupted, parallel to two faces which bevel the edges  $x$ ,  $y$ , and together produce an angle of about  $101^\circ 30'$ . Fracture conchoidal. Surface of some of the crystalline faces streaked, in general smooth and shining. Contains

	Dauphiné.	Hartz.
Silica	50.50	45.00
Lime	17.00	12.75
Alumina	16.00	19.00
Oxide of iron	9.50	12.25
Oxide of manganese	5.25	9.00
Potash	0.25	0.00
Boracic acid	0.00 Klaproth.	2.00 Wiegmann.

Before the blowpipe it intumesces and fuses readily into a dark-green glass, which becomes black in the oxidating flame; with borax it likewise exhibits the presence of iron, and on ex-

posure to heat becomes electric. The crystals have frequently a remarkable dichroism.

## OBSERVATIONS.

The finest crystals of this species occur with albite, prehnite, and quartz, at St Christophe, near Bourg d'Oisans, in Dauphiné; these are generally of a deep clove-brown colour, and are as remarkable for the brilliancy of their lustre, as for their size and symmetry of form. Smaller varieties are found in silver veins traversing mica-slate at Kongsberg in Norway; with hornblende or magnetic iron at Normark in Sweden; at Barèges in the Pyrenees; in Savoy; and in well defined, though rather more complex dark-coloured crystals at Botallack in Cornwall. There it is also found massive and compact, forming a peculiar kind of rock with garnet and tourmaline. The name *Thumite* or *Thumerstein* is derived from Thum, one of its localities near Ehrenfriedersdorf in Saxony. Axinite is susceptible of a good polish, but its peculiar colour, derived from manganese, wants that brilliancy which is requisite in an ornamental stone.

## CHRYSOLEITE.

Prismatic Chrysolite, *M.* and *J.* Olivine, *P.* Krisolith, Olivin, *W.* Peridot, *H.*

Sp. Gr. 3.3—3.5. H. = 6.5—7.0.

Prismatic. FIG. 125. Inclination of K to K over T =  $99^{\circ} 7'$ , of  $n$  to  $n = 130^{\circ} 2'$ . Colour various shades of green, particularly olive green, sometimes passing into brown. Transparent or translucent. Lustre vitreous. Streak white. Cleavage parallel to T. Fracture conchoidal. Contains

*Chrysolite.* Olivine from Unkel. Meteoric Iron.

Silica	39.0	50.0	38.48
Magnesia	43.5	38.5	48.42
Ox. of iron	19.0 Klap.	12.0 Klap.	11.19 Stromeyer.

Stromeyer noticed also a minute portion of nickel, and Klaproth, a little lime. Before the blowpipe it becomes darker, but neither fuses nor loses its transparency; unless borax be added, when a transparent green glass is formed. The colour of olivine is removed in heated nitric acid, the acid dissolving the iron, which is its colouring ingredient. Possesses distinct double refraction.

## OBSERVATIONS.

The term *chrysolite* refers to those varieties of the present species which are perfectly crystallized, and possess bright colours and high degrees of transparency; while that of *olivine* applies to imbedded masses of inferior transparency and less lively tints. The finest specimens of chrysolite are brought to this country from Constantinople, but their lo-



cality is unknown. It occasionally occurs in pale green transparent crystals among sand at Expaillic in Auvergne ; filling the cavities of ejected masses at Vesuvius ; in the Isle of Bourbon ; imbedded in obsidian at Real del Monte in Mexico (Poggen. Ann. vol. x.) ; and elsewhere.

Olivine is a more common variety, being met with abundantly in certain lavas, basalts, and other volcanic rocks. Crystals several inches in diameter are found in compact greenstone at Unkle, near Bonn on the Rhine ; large spheroidal masses in trap tuff at Kapferstein in Lower Styria ; at Habichtswald in Hessa ; and at Hecla and Vesuvius. These, however, are generally granular, disintegrating and falling to pieces on the pressure even of the hand. Olivine, therefore, is useless as a gem ; and chrysolite, though prized when of considerable dimensions, free of flaws, and of good colour, is too soft for the general purposes of the lapidary, being apt to lose its polish, unless worn with great care. Its largest and finest crystals, too, being frequently intersected with strata of cavities containing fluid, deteriorate its value when cut.

The *hyalosiderite* of Walchner (Brews. Jour. i. 184), though possessing inferior hardness and specific gravity, and containing a little more iron, is generally considered a variety of chrysolite. It occurs in small masses, imbedded in brown basaltic amygdaloid at the Kaiserstuhl in the Brisgau. Saussure's *chusite* and *limbelite* from the volcanic district of Limbourg, appear to be decomposed varieties of this species. The olivine, occupying the cavities of the meteoric iron discovered by Pallas in Siberia, has a peculiar straw-yellow colour, but otherwise is analogous to this.

Chrysolite is distinguished from chrysoberyl by inferior hardness ; from apatite, which it sometimes resembles, by being harder and heavier ; and from green tourmaline, by neither melting before the blowpipe, nor becoming electric when heated.

### CHONDRODITE.

Hemi-prismatic Chrysolite, *M.* Condrodite, Brucite, Maclureite, *P.* Condrodite, *H.* Chondrodite, *Levy.*

Sp. Gr. 3.15—3.25. H. = 6.5.

Hemi-prismatic. In indistinct crystalline masses, or imbedded grains of a wax-yellow or brown colour. Translucent, with a vitreous lustre. *Cleavage* scarcely observable. Consists of

	Pargas.	New Jersey.
Silica	38.00	32.66
Magnesia	54.00	54.00
Oxide of iron	5.10	2.33
Alumina	1.50	0.00
Potash	0.86	2.11
Fluoric acid	0.00 D'Ohsson.	4.09 Seybert.

Before the blowpipe it loses colour, becomes opake, and exhibits traces of fusion only on its thinnest edges. With borax it melts slowly into a transparent glass tinged with iron. The brown varieties act slightly on the magnetic needle; and generally it is not affected by nitric acid.

## OBSERVATIONS.

It occurs imbedded in calcareous spar near Äbo in Finland, and at Äker and Gulsjö in Sweden. The largest and most crystalline masses, however, were first discovered by Dr Bruce disposed in granular carbonate of lime, and associated with graphite, at Newton in New Jersey; and by him it was named *maclureite*. It has been met with accompanying magnetic and arsenical pyrites at Lochness in Scotland. The name chondrodite is derived from the circumstance of its occurring only in grains.

## BORACITE.

Tetrahedral Boracite, *M.* Octahedral Boracite, *J.* Borate of Magnesia, *P.* Borazit, *W.* Magnésie Boratée, *H.*

Sp. Gr. 2·8—3·0. H. = 7·0.

Tessular. FIG. 126. Inclination of *h* to *o* =  $125^{\circ} 16'$ ; of *d* to *o* =  $144^{\circ} 44'$ ; occasionally also assuming the forms of the regular dodecahedron and cube. Colour white or grey, inclining to yellow and green. Transparent, translucent, or opake. Lustre vitreous, inclining to adamantine. Streak white. Cleavage indistinct, parallel to *o*, the faces of the octahedron. Fracture conchoidal, uneven, and glistening. Contains

Boracic acid	54·55	69·96
Magnesia	30·68	30·04
Oxide of iron	0·57	0·00
Silica	2·27 Pfaff.	0·00 Arfwedson.

It intumesces before the blowpipe, and forms a glassy globule, which becomes crystalline, opake, and white, on cooling. Is electric when heated, four of its alternate terminal points being positive, the others negative; so that if the crystal be made to revolve round any one of its axes, the vitreous and resinous poles of the others succeed each other alternately. This experiment must be carefully made, in order to observe the property satisfactorily.



## OBSERVATIONS.

Boracite is principally found at the Kalkberg, a hill composed of gypsum, near Luneburg, in which it is disseminated in small but very perfect isolated crystals, associated with anhydrite, selenite, and rock salt. These crystals are limpid and transparent, present extremely elegant forms, and are of more frequent occurrence than the larger and in general more opaque varieties, which formerly were common, but for some years have been rarely met with at this locality. Segeberg, near Kiel, in the duchy of Holstein, is the only other repository of this mineral with which we are acquainted, and there it likewise occurs imbedded in gypsum, and associated with anhydrite. It has never been found massive.

## TOURMALINE.

Rhombohedral Tourmaline, *M.* Rhomboidal Tourmaline, *J.* Turmalin, Schorl, Aphrit, *W.* Tourmaline Apyre, *H.*

Sp. Gr. 3.0—3.2. H. = 7.0—7.5.

Rhombohedral. FIG. 127. Inclination of *P* to *P* =  $133^{\circ} 26'$ ; the opposite terminations of the crystal differently formed. *Colour* black or dark brown, green, blue, red, or white. Varying from transparent to almost opaque, according to the colour and the position in which it is viewed. *Lustre* vitreous. *Streak* white. *Cleavage* parallel to *P* and *s*, imperfect. *Fracture* uneven, or imperfect conchoidal. Faces of the prism deeply striated parallel to its axis, the rest generally smooth. Contains

*Red, Siberia. Green, Brazil. Blue, Uton. Black, Rubenstein.*

Silica	39.37	39.16	40.30	35.48
Alumina	44.00	40.00	40.50	34.75
Soda	0.00	0.00	0.00	1.75
Potash	1.29	0.00	0.00	0.48
Oxide of iron	0.00	5.96	4.85	17.44
Ox. of mangan.	5.02	2.14	1.50	1.89
Boracic acid	4.18	4.59	1.10	4.02
Lithion	2.62	3.59	4.30	0.00
Magnesia	0.00	0.00	0.00	4.68

Gmelin. Gmelin. Arfwed. Gmelin.

From this it naturally results that the comportment of these varieties before the blowpipe is dissimilar. In general, however, they more or less intumescence, some of them fusing with facility, others melting into a scoria, and the Rubellite not being acted upon at all. When exposed to heat, it becomes electric, the opposite terminations acquiring different poles, and when

rubbed, presents vitreous electricity. Dr Turner considers boracic acid an essential ingredient of all tourmalines.

#### OBSERVATIONS.

Tourmaline is a highly interesting mineral species, as well from the frequency and various modes of its occurrence, as from the diversity of aspect under which it is presented. It however is confined to primitive rocks, such as gneiss, granite, mica schiste, &c. and the veins which traverse these rocks; having never been met with either in the transition or secondary series. The largest and most striking black crystals of the above form occur in Greenland; at Hörlberg, near Bodenmais in Bavaria; at Kärlinbricka in Sweden; and near Bovey in Devonshire, coating the cavities of red granite, and associated with apatite. Small brilliant black crystals, having at first sight much the aspect of tin ore, are met with imbedded in white quartz in Norway; at St Just in Cornwall; and in decomposed felspar at Andreasberg in the Hartz, producing the sub-variety termed *aphrazite*. Large curved semi-crystalline prisms occur in granite at Portsoy in Banffshire; in Norway, Salzburg, the Tyrol, and elsewhere. These and similar black opaque varieties are termed *schorl*; while the remainder of the species come under the general denomination of tourmaline. This includes those pale green translucent crystals found imbedded in dolomite at St Gothard; the dark pistachio-green from Brazil; the blue kinds designated by D'Andrada *indicolite*, from the island of Uton in Sweden; the *rubellite* or red variety (a colour evidently derived from the manganese it contains), forming groups of diverging crystals in a species of lithomarge near Ekatharineburg in Siberia; the pale yellowish-brown crystals occurring in green talc at Windisch Kappel in Carinthia; the white specimens from St Gothard and Siberia; and the remarkable varieties from Chesterfield in Massachusetts, and Paris in New England, U. S. The granite of Massachusetts frequently presents, within a small space, the union of red, green, blue, and black crystals; and, what is still more extraordinary, the red appear frequently inclosed within the green, or the black occupies the centre, a violet blue forming the envelope. In such cases there exists a distinct continuity of structure, the cleavage of the one being prolonged throughout the other; and their electrical properties are similar. Some Siberian specimens are very remarkable in this respect, presenting interiorly a brown or blue colour, which is surrounded with carmine red, or some other lighter tinge; or interiorly a red hue, bordered with pistachio-green; and so forth. The Elba crystals, when transparent, frequently exhibit parallel zones of distinctly different colours, being red at their two extremes, and dark blue in the centre, or partly grass-green, partly azure blue, &c.

Tourmaline, also, has the singular property of exhibiting different colours, according as it is viewed parallel or perpendicular to the axis of its crystals, and almost invariably is less transparent in the first of these directions than in the last. Some Ceylonese specimens have a bluish



tinge parallel, and a red colour perpendicular to their axis; or a liver-brown in one direction, and a reddish-brown in the other. This peculiarity must be attended to, on cutting the stone for ornamental purposes.

Sometimes the prisms of tourmaline are extremely short and thick; those from Devonshire and St Gothard in particular; and at others are acicular or even capillary, as the light pistachio-green variety from Cornwall, which has much the aspect of acicular arseniate of copper. The rubellite or *siberite* from Siberia is a rare variety. A celebrated specimen, presented to Mr Greville by the king of Ava, and now in the British Museum, was valued at L.500 sterling. Rubellite generally occurs in diverging crystalline groups; occasionally also in large very perfect prisms, deeply striated longitudinally, a variety of which in my father's collection contains a magnificent crystal. In Moravia thin prismatic crystals of a pale peach-blossom colour accompany lepidolite; they contain upwards of 6 per cent. of manganese. Rolled tourmalines occur in Brazil, Ceylon, and elsewhere; those of Ceylon being associated with pleonaste, which in this state has a similar aspect, but the facility with which tourmaline becomes electric when heated, is sufficiently characteristic. At St Just in Cornwall it is met with massive, though this is perhaps its rarest form.

The varieties of tourmaline, though differing from each other as much in appearance and colour as in chemical composition, yet present precisely the same angles; their specific gravity is nearly identical; their electrical properties are easily excited in specimens from every locality, and of every tint; and no distinction has been observed in the optical characters of any hitherto examined.

On being rubbed, tourmaline becomes positively electric; and, when exposed to a certain degree of heat, acquires positive electricity at that termination of the crystal which has the greatest number of facets, and negative electricity at the other. This is the general rule; but when heated to a particular point, it no longer indicates the presence of electricity. As it cools, however, this re-appears, until its temperature is reduced to nearly 32° F. when it is again lost. If exposed to more intense cold, the electricity appears with opposite characters, that termination of the crystal which had formerly exhibited resinous electricity being now vitreous, and *vice versa*. If a prism of tourmaline be broken when in a state of excitation by heat, each fragment presents two opposite poles, in the same manner as the artificial magnet; and Sir David Brewster has observed that it preserves this pyro-electricity even when in a powdered state.

Few gems afford a finer suite of colours than this, but the hues of tourmaline are for the most part dingy, and seldom sufficiently bright. Some of the Brazilian, Siberian, and Ceylon varieties, however, are used for imitating gems of much higher value, particularly those of green, yellow, or red colours; which are respectively transformed into the semblances of emerald, topaz, and red sapphire. Of these the yellow tour-

maline from Ceylon, which is a rare mineral, falls little short of real topaz; the others are in general greatly inferior. In such cases, the specific gravity is sufficiently characteristic; and the facility with which tourmaline becomes electric when heated, will prevent its being confounded with any of the more noble gems. The Siberian rubellite, cut *en cabochon*, presents a milky-like chatoyant lustre.

The ancients were well acquainted with tourmaline, and with its electrical properties; though to the moderns it did not become an object of interest before the year 1717, when Lemerey published his discoveries.

### IDOCRASE.

Pyramidal Garnet, *M.* Pyramidal Garnet, or Vesuvian, *J.* Idocrase, *P.* Vesuvian, Egeran, Loboit, Frugardit, Idokras of the Germans. Idocrase, *H.*

Sp. Gr. 3.3—3.4. H. = 6.5.

Pyramidal. FIG. 128. Inclination of *c* to *d* = 127° 7'. Colour brown, passing into various shades of green; rarely black, blue, or yellow. Lustre highly vitreous or resinous. Semi-transparent, sometimes almost opaque. Cleavage parallel to *P*, *d*, and *M*, indistinct. Fracture imperfect conchoidal. Contains

	Vesuvius.	Monzoni.	Piemont.
Silica	35.50	37.64	34.85
Alumina	33.00	16.68	21.93
Lime	22.25	38.24	33.61
Magnesia	0.00	0.00	0.00
Oxide of iron	7.50	6.42	5.40
Ox. of mangan.	0.25 Klap.	0.00 Kobell.	0.00

Fuses before the blowpipe with effervescence, into a translucent yellow globule, and forms with borax a diaphanous glass tinged by iron.

### OBSERVATIONS.

This mineral was first noticed at Vesuvius, and thence derived its trivial appellation of *vesuvian*. Sig. Monticelli of Naples possesses several disengaged crystals from that locality, which exceed an inch in each direction; but the Vesuvian specimens are usually of a small size, and though their general prismatic form is easily traced, their modifications are varied and complicated in the extreme. Vesuvius is the only volcanic district which yields it in profusion; and there it is confined to ejected masses of ancient date, in which it occurs either of a hair-brown or an olive-green colour, associated with ice-spar, mica, garnet, and nepheline. It occurs also at Albano near Rome; but has never been observed, either among the extinct volcanoes of Auvergne, or in the Plutonian district of the Rhine. The most simple crystalline forms



of idocrase (fig. 28), are those of the Wilui River, and Lake Baikal, in Siberia, where it occurs detached and imbedded in decomposed serpentine. But by much the finest specimens come from Ala, in the Val di Brozzo in Piedmont. These in general are semi-transparent, present fine olive-green, hair brown, and, though rarely, perfect black colours; are deeply streaked in a longitudinal direction; and are as remarkable for brilliancy and lustre, as for the symmetry and perfection of their crystalline forms. Large well-defined opaque crystals, often exceeding four or five inches in diameter, occur at Egge, near Christiansand in Norway. These consist of a number of coats or envelopes, which admit of being removed in succession; and thus a more distinct form is frequently obtained by taking off the outer portion. At Monzoni in the Fassa valley, idocrase is met with in brown crystals devoid of the face P; also latterly in pretty large individuals of a sulphur-yellow hue. *Egeran*, from Haslau, near Eger in Bohemia, presents liver-brown diverging groups of deeply streaked imperfect crystals; and the *cyprine*, or cupreous idocrase, described by Berzelius, from the vicinity of Tellemarken in Norway, exhibits occasionally crystalline faces, and has a fine blue tinge, arising, it is believed, from a minute portion of copper.

The more transparent crystals from Piedmont frequently, like tourmaline, present different colours, as they are viewed parallel or perpendicular to their axis; being pistachio-green when perpendicular, and oil-green when parallel, to the prismatic axis. Idocrase admits of a good polish, and at Naples and Turin is formed into various ornaments, which are sold, according to their colours, under the denomination of hyacinth, chrysolite, &c. I have never met with a finer suite of idocrase, than that contained in my father's collection.

### HELVINE.

Tetrahedral Garnet, *M.* Helvine, *J. W.* and *H. Gmelin*, Brewster's Jour. II. 268.

Sp. Gr. 3.1—3.3. H. = 6.0 = 6.5.

Tessular. FIG. 129. The tetrahedron with its solid angles replaced. Colour wax-yellow, inclining to yellowish-brown or siskin green. Translucent on the edges. Lustre vitreous, inclining to resinous. Streak white. Cleavage, traces of the octahedron. Fracture uneven. Contains

Silica	39.50	35.27
Alumina	15.65	1.45
Oxide of iron	37.75	7.99
Oxide of manganese	3.75	29.44
Sulphate of do.	0.00	14.00
Lime	0.50	0.00
Glucina	0.00 Vogel.	8.03 Gmelin.

In the reducing flame of the blowpipe, it fuses with effervescence into an opake globule of almost the same colour as the mineral; and with borax yields a transparent glass, coloured of an amethystine hue by manganese.

## OBSERVATIONS.

The only published analyses of this rare mineral are the above, which present such discrepancies, that we should be at a loss for its real composition, did not the masterly analyses of Gmelin place him among the first analytic chemists of the present day. Schwartzenberg in Saxony, where it occurs in beds of gneiss, accompanied with garnet, quartz, fluor, and calc spar; and Hortekulle, near Modum in Norway, are the only localities of helvine with which we are acquainted. It was named by Werner from its decided yellow colour, after the Greek *ἥλιος*, the sun.

## GARNET.

Dodecahedral Garnet, *M.* and *J.* Garnet, *P.* Grossular, Melanite, Granat, Allochroit, Pirop, Pirenait, Kolophonit, Almandin, Braunsteinkiesel, *W.* Grenat, *H.*

Sp. Gr. 3.5—4.3. H. = 6.5—7.5.

Tessular. FIG. 11. *Form* the dodecahedron. *Colour* red, brown, green, yellow, and black. Transparent or translucent. *Lustre* vitreous or resinous. *Streak* white. *Cleavage* parallel to the faces of the dodecahedron indistinct. *Fracture* conchoidal. Though the different varieties differ materially in composition, they nearly all fuse before the blowpipe into a black glassy globule, which frequently acts upon the magnet. They consist of

	<i>Essonite.</i>	<i>Precious Garnet.</i>	<i>Melanite.</i>	<i>Grossular.</i>
Silica	38.80	35.75	35.5	40.55
Alumina	21.20	27.25	6.0	20.10
Lime	31.25	0.00	32.5	34.86
Oxide of iron	6.50	36.00	25.2	5.00
Ox. of mangan.	0.00	0.25	0.4	0.48
	<i>Klaproth.</i>	<i>Klaproth.</i>	<i>Klaproth.</i>	<i>Wachtmeister.</i>
	<i>Pyrope.</i>	<i>Colophonite.</i>	<i>Allochroite.</i>	<i>Pyrenaite.</i>
Silica	40.0	37.0	35.0	43.0
Alumina	28.5	13.5	8.0	16.0
Lime	3.5	29.0	30.0	20.0
Oxide of iron	16.5	7.5	17.0	16.0
Ox. of mangan.	0.3	4.8	3.5	0.0
Magnesia	10.0	6.5	0.0	0.0
Water	0.0	1.0	0.0	4.0
	<i>Klaproth.</i>	<i>Simon.</i>	<i>Vauquelin.</i>	

Pyrope contains also two per cent. of chromic acid.



## OBSERVATIONS.

The varieties of garnet are so numerous, that many of them have received peculiar designations; while the marked difference in their specific gravity and chemical composition, affords sufficient grounds in the opinion of some mineralogists for separating them entirely. *Precious garnet* presents fine red colours, with occasionally a tinge of yellow or blue, or a smoky aspect; it is translucent or transparent, and occurs in imbedded crystals or grains. Its principal localities are Ceylon and Greenland, whence many fine stones are obtained for the purposes of the lapidary; but in smaller individuals it is also found associated with diopside and talc at Ala in Piemont, sometimes near Ely in Fifeshire, and in several parts of Bohemia. It is subdivided into *almandine* and *pyrope*, according to its degrees of transparency.

*Common garnet* differs in being opaque, or at least but slightly translucent. Its crystals are generally implanted; and in some localities, at Fahlun in Sweden, Arendal and Kongsberg in Norway, and the Zillertal, for instance, occur in regular dodecahedrons, occasionally larger than the fist. It is found abundantly in certain mica-slates, as in the island of Mull, in the shires of Perth and Inverness, in Shetland, and in many places on the Continent. At Domo d'Ossola on the Simplon, this description of mica-slate forms excellent millstones. At Schwartzenberg in Saxony, and in the Bannat of Temeswar, garnet occurs in peculiarly green coloured crystals; at Vesuvius, in the cavities of ejected stones; also in Hungary, Styria, and other places. *Melanite* is perfectly black; it is met with in dodecahedrons, whose edges are replaced, imbedded in lava at Vesuvius, and in the neighbourhood of Rome. *Grossular* and *Pyrenate* also occur in imbedded crystals; of which the first has a pale gooseberry-green colour (whence its name), assumes generally an icositetrahedral form, and occurs near the river Willui in Siberia; the last is found in minute black extremely symmetrical dodecahedrons, in primitive limestone at the Pic Eres Lids, near Barèges in the Pyrenees. *Topazolite* forms small yellow crystals at Mussa in Piemont. *Colophonite*, presenting yellowish- and reddish-brown, or oil green and honey yellow colours, consists of round particles, which may be separated with facility. When the composition is impalpable, or the particles so intimately connected that they cannot be distinguished, *Allochroite* is formed. *Colophonite* is principally found at Arendal; *Allochroite* in the neighbourhood of Drammen in Norway.

The *Cinnamon-stone*, *Essonite*, or *Kancelstein* of the Germans, was described by Haüy as a particular species; but the close agreement of its properties with those of garnet scarcely admit of any distinction being drawn between them. Its colour is intermediate between hyacinth-red and orange-yellow; it is either transparent or translucent, and though usually found in grains among the sand of certain Brazilian rivers, occurs also in considerable masses in some of the primitive rocks of Ceylon. When large, well coloured, and transparent, it is used as a gem. The

*Romanzovite* of Nordenskiöld, from Kimito in Finland, is apparently a variety of cinnamon-stone.

*Aplome* is Haüy's name for a variety of garnet, which he distinguished in consequence of the dodecahedral faces of its crystals being streaked in the direction of their short diagonals. Its colour is brown, sometimes greenish; and its specific gravity only 3.44; otherwise its characters are not so distinct as to admit of its being separated from garnet. Its localities are the banks of the river Lena in Siberia, and Schwartzenberg in Saxony.

When of a rich colour, and free from flaws and cracks, the garnet species forms a valuable gem; pyrope, in particular, which, if of considerable magnitude, is highly prized: its colour, however, is frequently so intense that it requires to be excavated on one side. When cut, it may be mistaken for certain other gems; but the red hue of the garnet is more sombre than that of either corundum or spinel. It generally also acts on the magnet, which is not affected by either of the others. Some varieties of garnet, from their frequency, render it an important mineral to the geologist; while others serve the iron smelter at once with a useful flux and a rich ore of iron. Coarse garnets finely pulverized, are used instead of emery for polishing metals. The following vitreous composition imitates garnet:—Purest white glass two ounces, glass of antimony one ounce, powder of cassius one grain, manganese one grain.

### STAUROLITE.\*

Prismatoidal Garnet, *M.* Prismatic Garnet or Grenatite, *J.* Staurolite, *P.* Staurolith, *W.* Staurotide, *H.*

Sp. Gr. 3.3—3.9. H. = 7.0—7.5.

Prismatic. FIG. 130. Inclination of *M* to *M* = 129° 31'. Colour dark reddish brown. Translucent or opaque. Lustre vitreous, inclining to resinous. Streak white. Cleavage parallel to *o*. Fracture conchoidal. Consists of

	Brittany.	St Gothard.
Silica	33.00	37.60
Alumina	44.00	41.00
Lime	3.84	0.00
Magnesia	0.00	0.50
Oxide of iron	13.00	18.25
Ox. of manganese	1.00 Vauquelin.	0.50 Klaproth.

It assumes a darker hue before the blowpipe, but does not

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\* A name improperly applied by some mineralogists to harmotome.



melt; and with borax fuses slowly into a transparent deep green coloured glass.

## OBSERVATIONS.

Simple crystals occur at St Gothard in Switzerland, accompanying kyanite, and imbedded in talc slate; also in the Greiner Mountain, Tyrol. At both those localities it is sometimes curiously associated with the kyanite; these two minerals, so different in aspect, presenting themselves in continuous position, as if forming one and the same crystal, disposed sometimes parallel, sometimes at right angles, to the axis. This is a solitary instance in mineralogy. Twin crystals of considerable magnitude, intersecting and crossing each other at particular angles, and superficially of a dull-brown colour, are met with in Bretagne; and several other varieties occur in Spain, Iceland, some of the Hebrides, and North America, generally dark coloured and opaque. The specific gravity of the twin crystals from Spain is so low as 3·3 or 3·4; about 3·7, however, is its average.

## ZIRCON.

Pyramidal Zircon, *M.* and *J.* Zircon, *P.* Zirkon, Hyacinth, *W.* Zircon, *H.*

Sp. Gr. 4·5—4·7. H. = 7·5.

Pyramidal. FIG. 131. Four-sided prisms, surmounted by four-sided pyramids. Inclination of P to P =  $123^{\circ} 19'$ ; of P to *l* =  $132^{\circ} 10'$ . Colour red, brown, yellow, grey, white. Transparent, faintly translucent. Lustre adamantine. Streak white. Cleavage parallel both to P and *l*. Fracture conchoidal and brilliant. Consists of

	<i>Zircon.</i>	<i>Hyacinth.</i>	<i>Jargoon of Ceylon.</i>
Zirconia	69·0	70·0	66·0
Silica	26·5	25·0	31·0
Oxide of iron	0·5 Klaproth.	0·5 Klaproth.	2·0 Vauquel.

It becomes colourless, but does not *per se* fuse before the blowpipe, although with borax it melts into a diaphanous glass.

## OBSERVATIONS.

This species is divided into Hyacinth, Jargoon, and Zirconite; the first applying to such varieties as possess bright colours, considerable transparency, and whose crystals and grains have smooth and shining surfaces; the second principally referring to those from Ceylon, which are devoid of colour, or have a smoky tinge, and from that circumstance are occasionally sold as inferior diamonds; while zirconite, besides presenting tints which incline more to grey and brown, is frequently rough and opaque. Hyacinth is principally found in grains and rolled crystals, in the sand and alluvial deposits of certain rivers in Ceylon; at Expailie

near Puy in France; at Ohlapian in Transylvania; and near Billin in Bohemia; occasionally also imbedded in volcanic tuff in Auvergne, at the Laacher See near Bonn, and at Vesuvius.

The finest crystallized zircons known in this country were, within these few years, brought by Menge from Miask in Siberia, some of them as large as walnuts. Magnificent specimens also occur in Greenland, at Bunkum in South Carolina, and in the zircon-syenite of Fredericks-warn in Norway. Smaller individuals are found in several granite and gneiss rocks, as at the Sau-alpe in Carinthia, in the vicinity of Stockholm, at Baltimore and New Jersey in North America, at Scalpay in Harris, and in Kirkcudbrightshire.

Hyacinth is not highly valued as a gem; for though its colour is occasionally brilliant, it rarely occurs of sufficient dimensions. It is the heaviest of the gems, and may be distinguished with facility by means of its superior specific gravity.

### FIBROLITE.

Fibrolite, J. and P.

Sp. Gr. 3.214. H. superior to quartz.

Massive, with a fibrous or columnar composition. *Colour* white or grey, inclining to green. *Opake*. *Cleavage* imperfect. *Fracture* conchoidal. Consists, according to Chenevix, of

	Carnatic.	China.
Silica	38.00	33.0
Alumina	58.25	46.0
Oxide of iron	0.75	13.0

It is infusible before the blowpipe, and emits a phosphorescent light when two pieces are rubbed together.

### OBSERVATIONS.

This mineral occurs associated with corundum in China and the Carnatic. It appears to be closely allied to the following species.

### BUCHOLZITE.

*Brandes*, Schweiggers, Jour. XXV. 125., *Thomson*, Royal Soc. Trans. XI. 263.

Sp. Gr. 3.19. H. = about 6.0.

Massive. Amorphous, possessing a fibrous structure. *Colour* white or grey, inclining to yellow. Thin fragments slightly translucent. *Lustre* pearly and glistening. *Fracture* conchoidal, perpendicular to the fibres. Brittle, and easily frangible.



	Tyrol.	America.
Consists of Silica	46.0	46.40
Alumina	50.0	52.92
Potash	1.5	0.00
Oxide of iron	2.5 Brandes.	traces. Thomson.

## OBSERVATIONS.

Bucholzite was known only from Fassa in the Tyrol, until Dr Thomson published his description and analysis of the American variety from Chester on the Delaware. The latter appears to be purer than the Tyrolese variety, and its hardness is stated to be considerably higher. Its composition is very analogous to that of Sillimanite, as analysed by Bowen (*vide* p. 162.)

## FORSTERITE.

Forsterite, *Levy*. Ann. of Phil. XXXVII. 61.

H. about 7.0.

Prismatic. FIG. 132. Inclination of M to M =  $128^{\circ} 54'$ ; of *y* to *y* over M =  $107^{\circ} 48'$ ; of *y* to *y* adjacent =  $139^{\circ} 14'$ . Colourless and brilliant. Translucent. *Cleavage* perfect and easily obtained parallel to *o*. Contains silica and magnesia, according to Children.

## OBSERVATIONS.

This mineral was discovered by Levy, in small crystals, accompanying pleonaste and olive-green pyroxene, on Mount Vesuvius. Its angles pretty nearly correspond with those of chrysoberyl; but its cleavage perpendicular to the axis, which is extremely distinct in Forsterite, has not been observed in that mineral.

## HUMITE.

*Bournon*, Catalogue. Humite, P.

Sp. Gr. 3.1—3.2. H. = 6.5—7.0.

Prismatic. In minute very complicated crystals, often macled. Colour yellow, passing into white or reddish-brown. Transparent, translucent. *Lustre* vitreous. Brittle. *Fracture* imperfect conchoidal. *Cleavage* easily obtained, parallel to the base of a right rhomboidal prism. Before the blowpipe it becomes opaque, but does not melt, and with borax affords a clear glass.

## OBSERVATIONS.

It accompanies mica, pleonaste, and other minerals, among the ejected masses of Monte Somma; the crystals, though small, being extremely distinct. Monticelli arranges it with chondrodite.

## LIGURITE.

Ligurite, P. Ligurit, L.

Sp. Gr. 3.49. H. above 5.0.

In oblique rhombic prisms of  $140^\circ$  and  $40^\circ$ . *Colour* apple-green, sometimes speckled externally. Transparent or translucent. *Lustre* of the fracture intermediate between vitreous and resinous. *Streak* greyish white. *Fracture* uneven. Consists of

Silica	57.45
Alumina	7.36
Lime	25.30
Magnesia	2.56
Oxide of iron	3.00
Oxide of manganese	0.50 Viviani.

## OBSERVATIONS.

Ligurite is considered superior as a gem, to chrysolite, in colour, hardness, and transparency. It occurs in a talcose rock on the banks of the Stura, in the Appenines of Liguria. It does not become electric either by heat or friction, and does not emit any phosphorescence on live coals.

## OSTRANITE.

Breithaupt, Edin. New Phil. Jour. IV. 186.

Sp. Gr. 4.32—4.40.

FIG. 131. Inclination of P to P, the adjacent angles of the pyramid =  $128^\circ 14'$ , and  $133^\circ 42'$ ; of *l* to *l*, the adjacent angles of the prism, =  $96^\circ$  and  $48^\circ$ . *Colour* clove-brown. *Lustre* vitreous. Very brittle. It does not fuse before the blowpipe, but its colour becomes paler; with borax it melts, though with difficulty, into a transparent glass. In nitric acid it is insoluble.

## OBSERVATIONS.

Breithaupt obtained the above description from crystals belonging to Mr Heyer of Dresden. They were brought from Norway by Nepperschmidt, and are supposed to belong to the zircon syenite of Fredericks-warn. They are not unlike zircon either in form or appearance, but have a different angle.



## MELLILITE.

Mellilite, *J. P. and H.*

Sp. Gr. 3·24—3·28. Gives sparks with steel.

Prismatic. In small four-sided prisms, having the lateral edges replaced, as in fig. 82. Inclination of *s* to *M* = 135°. *Colour* yellow, inclining to red or green. *Opake*. *Lustre* vitreous. Contains, according to Carpi, silica 38·0, lime 19·6, magnesia 19·4, alumina 2·9, oxide of iron 12·1, oxide of titanium 4·0, oxide of manganese 2·0. Before the blowpipe it melts, without effervescence, into a greenish glass, and, when reduced to powder, gelatinizes with nitric acid.

## OBSERVATIONS.

It is found at Vesuvius, and at Capo di Bove near Rome, in the fissures of volcanic rocks, accompanying nepheline, pleonaste, and other minerals. Its name is derived from its honey-like colour.

## SAPPHIRINE.

*Stromeyer. Levy.*Sp. Gr. 3·42. *H.* = 7·0—8·0.

Disseminated in small grains. *Colour* pale-blue or green. Translucent. *Lustre* vitreous. *Fracture* imperfect conchoidal. Contains silica 14·50, alumina 63·11, magnesia 14·85, lime 0·38, oxide of iron 3·92, oxide of manganese 0·53, water 0·49—Stromeyer.

## OBSERVATIONS.

It was discovered by Gièsécke, associated with mica and fibrous brown anthophyllite, at Akudlek in Greenland. It somewhat resembles sapphire, but was distinguished and described by Stromeyer.

## SPHÆRULITE.

*Spærulite, J. and P.*Sp. Gr. 2·4—2·54. *H.* = 6·5—7·0.

Occurs in roundish or spheroidal imbedded masses, whose surface is sometimes rough, sometimes quite smooth. *Colour* brown, yellow, or grey. *Opake*. No regular cleavage. It is almost infusible before the blowpipe, the edges only becoming covered

with a sort of enamel; and, in respect to composition, appears to be nearly related to obsidian.

## OBSERVATIONS.

This mineral is met with in round nodules imbedded in pitchstone at Spechtshausen, in Saxony; in radiated orbicular masses in ash-grey pearlstone at Glashutte, near Schemnitz in Hungary; in round balls which have a radiated fibrous structure, disposed in soft friable clay, which is evidently a decomposed rock, in the Shetland islands; and in botryoidal masses of a bright yellow colour in Brittany. It was first distinguished by Breithaupt.

## ZEAGONITE.

Abrazite, Zeagonite, P. Gismondin, L.

H. = 7.0—7.5

FIG. 64, somewhat flattened. Inclination of P to P =  $122^{\circ} 54'$ , of P to *l* =  $132^{\circ} 31'$ . Colour pale smalt blue, grey, white, and reddish. Translucent, or almost transparent, in small crystals. Lustre adamantine. Cleavage parallel to *l*, imperfect. Fracture conchoidal. Consists of

Silica	57.45
Alumina	7.36
Lime	25.30
Magnesia	2.56
Oxide of iron	3.00
Oxide of manganese	0.50 Viviani.

It phosphoresces, and becomes friable before the blowpipe, but does not melt. It gelatinizes in acids without effervescence.

## OBSERVATIONS.

Zeagonite occurs in small pale purple-coloured crystals in the drusy cavities of ice-spar, and other volcanic minerals, at Vesuvius. The Gismondine of Leonhard is found in white translucent crystals, coating cavities of ancient lava at Capo di Bove, near Rome; though differing considerably in appearance, its other properties coincide with those of zeagonite.



## ORDER ORE.

## GADOLINITE.

Prismatic Melane Ore, *Haid.* Prismatic Gadolinite, *M. and J.* Gadolinit, *W* Gadolinite, *H.*

Sp. Gr. 4.2—4.3. H. = 6.5—7.0.

In imperfect oblique prisms of  $109^{\circ} 28'$ , and  $70^{\circ} 32'$ . *Colour* black, or greenish black. *Lustre* vitreous, inclining to resinous. Translucent on the edges, or almost opaque. *Streak* greenish-grey. *Cleavage* imperfect. *Fracture* conchoidal. Contains

	Finbo.	
Yttria	45.00	45.93
Protox. of iron	11.43	11.34
Protox. of cerium	17.92	16.90
Silica	25.80 Berzelius.	24.16 Berzelius.

Before the blowpipe it decrepitates, and fuses when in thin splinters; but if heated with precaution upon charcoal, it incandesces at once, and its colour becomes paler. With borax it forms a globule deeply coloured with iron, which in the reducing flame assumes a bottle-green tinge. It loses its colour in heated nitric acid, and is converted into a jelly.

## OBSERVATIONS.

This mineral was first noticed in the year 1794, by M. Gadolin, who discovered in it a new earth, which afterwards received the name of yttria. Its principal localities are the quarries of Karafvet and Finbo, near Fahlun in Sweden. Both there, and at Ytterby near Stockholm, it occurs indistinctly crystallized, and in rounded masses, which are often encircled with a yellow crust, and imbedded in coarse-grained granite. Mr Wallman of Fahlun possesses a crystal from Karafvet which is four inches long. It has likewise been found at Disko in Greenland, and imbedded in granite in Ceylon.

## ALLANITE.

Anorthitic Melane Ore, *Haid.* Prismatic Cerium Ore, or Allanite, *P.* Allanite, *J. Thomson* in Royal Soc. Trans. Edin. VI. 371.

Sp. Gr. 3.5—4.0. H. = 6.0.

Tetarto-prismatic. FIG. 133. Inclination of P to  $r = 116^\circ$ , of  $r$  to M =  $129^\circ$ , of M to P =  $115^\circ$ . Generally massive. Colour black, with a greenish or brown tinge. Opake, faintly translucent and brown when in thin splinters. Lustre imperfect metallic. Streak greenish-grey. Cleavage parallel to  $r$  and P, indistinct. Fracture imperfect conchoidal. Consists of

Oxide of cerium	33.9
Oxide of iron	25.4
Silica	35.4
Lime	9.2
Alumina	4.1
Moisture	4.0—Thomson.

Before the blowpipe it froths, and melts imperfectly into a black scoria; and in nitric acid gelatinizes.

## OBSERVATIONS.

Allanite is by Berzelius united with cerine, and by Haidinger with orthite. It closely resembles both these minerals in certain respects, but differs so materially from them in others, that, until more accurately described, they are better separate. The above analysis by Dr Thomson presents a large excess, which renders a new chemical examination of Allanite desirable. It only occurs at Alluk, near the southern extremity of East Greenland, where it was discovered by Giesècké imbedded in granite. It was first discriminated by my father among part of that gentleman's collection, which was captured, and sold at Leith, in the year 1807. It usually appears in black vitreous-like masses, rarely crystalline; though I possess one individual exceeding an inch in length, from which the above figure was delineated.

## ORTHITE.

Orthite, *P.* Orthit, *Berzelius.* Brews. Jour. III. 553.

Sp. Gr. 3.2—3.3. H. = 5.0.

Occurs either massive or in long thin acicular crystals. Colour ash-grey, inclining to black. Opake. Lustre vitreous. Streak brownish-grey. Fracture conchoidal. Contains silica



32.00, lime 7.84, alumina 14.80, oxide of cerium 19.44, protoxide of iron 12.44, oxide of manganese 3.40, yttria 3.44, water 5.36—Berzelius. Before the blowpipe it froths, becomes yellowish-brown, and melts with effervescence into a black vesicular globule; with borax into a transparent ore. In heated acid it gelatinizes.

## OBSERVATIONS.

Orthite presents itself under two very different aspects. In acicular diverging dark-brown coloured prisms, sometimes exceeding a foot in length, imbedded in quartz, at Finbo near Fahlun in Sweden; and in black vitreous masses, disseminated through granite, at Skeppsholm, one of the islands on which Stockholm is built. This last, from its resemblance to Gadolinite, was considered a variety of that species, until distinguished by Wöhler. Orthite also occurs at Lindenaes in Norway, and was brought from Greenland by Giesècké.

Gadolinite, Allanite, and Orthite may be distinguished most easily, by means of their different degrees of specific gravity and hardness. Their chemical composition is also very different.

## SPHENE.

Hemi-prismatic Titanium Ore, *M.* Prismatic Titanium Ore or Sphene, *J.* Sphene, *P.* Braun-Menakerz, Gelb Menakerz, *W.* Sphen, *Haus.* Titanit, *L.* Sphène Titane Silicéo-Calcaire, *H.*

Sp. Gr. 3.3—3.6. H. = 5.0—5.5.

Hemi-prismatic. FIG. 134. Inclination of  $n$  to  $n = 136^\circ 8'$ , of  $P$  to  $y$  adjacent =  $60^\circ 24'$ . Colour brown, yellow, grey, or green. Transparent, or translucent on the edges. Lustre adamantine, sometimes inclining to resinous. Streak uncoloured. Cleavage parallel to  $r$  and  $P$ , but not easily obtained.

Contains Lime	33.0	32.2
Ox. of titanium	33.0	33.3
Silica	35.9 Klaproth.	28.0 Cordier.

with a trace of manganese.

Before the blowpipe the yellow varieties do not change their colour; all the rest become yellow. They slightly intumesce, and melt on the edges into a dark-coloured enamel; and with borax afford a yellowish-green glass. They are soluble in heated nitric acid, leaving a siliceous residue.

## OBSERVATIONS.

The brown and the yellow menachine ore of Werner, or titanite and sphene, differ principally in their colours, and the degrees of transparency con-

nected with them. The first is brown and almost entirely opaque, while the last is at least translucent, and presents various pale-brown, yellow, green, and grey colours. Titanite occurs with augite in beds of iron-ore at Arendal in Norway; in a granitic rock at Sartut in Greenland; and with scapolite and tremolite in the limestone quarry of Malsjö in Wermland, Sweden. Sphene again, is met with, in pale-green transparent crystals of considerable magnitude, frequently macled in the most fantastic manner, and associated with felspar and chlorite at Graubinden in the Grisons; on mica slate at St Gothard; in distinctly pronounced brownish crystals disposed on chlorite, at the Val Maggia in Piemont; of a yellowish grey colour, accompanying the rock crystals of Mont Blanc; and elsewhere among the Alps. Small crystals occur in certain syenites, as at Strontian in Argyleshire, and Criffle in Galloway. More rarely it appears among volcanic rocks, as at the Laacher See, and Andernach on the Rhine.

### PYROCHLORE.

Octahedral Titanium Ore, *M. Pyrochlore*, *Brewster*, Jour. VI. 358.

Sp. Gr. 4.2—4.25. H. = 5.0.

Tessular. Octahedron. *Colour* dark reddish-brown, the fresh fracture almost black. Slightly translucent on the edges, or opaque. *Streak* pale-brown. *Fracture* conchoidal, with a resinous or vitreous lustre. *Cleavage* none. Consists, according to Wöhler, of titanic acid 62.75, lime 12.85, protoxide of uranium 5.18, oxide of cerium 6.80, protoxide of manganese 2.75, oxide of tin 0.61, oxide of iron 2.16, water 4.20. It also contains much fluoric acid. Before the blowpipe, it becomes pale brownish yellow, but retains its lustre, and melts with great difficulty into a blackish-brown scoria. It is perfectly dissolved in borax, and with effervescence, also in salt of phosphorus, affording with the former a reddish-yellow transparent globule in the oxidating flame, which becomes opaque on flaming; and a deep red one in the reducing, which changes into a bluish-grey enamel on flaming. With the latter it yields a yellow-coloured globule in the oxidating flame, which becomes grass-green on cooling, and which again is superseded by a deep red colour when placed in the reducing flame.

### OBSERVATIONS.

Pyrochlore was discovered by Otto von Tank, and received its name from Berzelius, in allusion to its property of turning yellow when exposed to the blowpipe. It has considerable resemblance to the zircon, with which it occurs imbedded in syenite, at Frederickswarn and Laurvig



in Norway. It has also been brought from Greenland, but is by no means a mineral of frequent occurrence.

### RUTILE.

Peritomous Titanium Ore, *M.* Prismato-Pyramidal Titanium Ore, *J.* Titanite, Nigrine, *P.* Rutil, Nigrine, *W.* Titane Oxydé, *H.*

Sp. Gr. 4.2—4.4.  $H. = 6.0-6.5.$

Pyramidal. FIG. 135. Inclination of  $c$  to  $c = 117^{\circ} 2'.$  *Colour* reddish-brown, passing into red. Translucent or opaque. *Lustre* metallic-adamantine. *Streak* very pale brown. *Cleavage* perfect in two directions. If pure, it consists solely of oxide of titanium, in the proportion, according to Berzelius, of 56.05 metal, and 33.95 oxygen. Nigrine, however, contains about fourteen per cent. of the oxide of iron. *Per se* it does not fuse when exposed to the blowpipe, but yields with borax in the reducing flame a yellow glass, which assumes an amethyst colour when still farther heated. Its most distinguishing character is the streak.

### OBSERVATIONS.

Rutile occurs in the Grisons, disposed in red translucent flat prisms on crystals of Fer oligiste. Generally speaking, however, it forms irregular longitudinally-streaked prisms, which are imbedded in either colourless or white quartz. At Crianlarich in Perthshire, these have occasionally been met with of considerable dimensions; also in Brazil, Siberia, and at St Gothard. Some of the Brazilian varieties are extremely beautiful, consisting of red transparent acicular crystals, inclosed in limpid quartz, and branching off from each other with the greatest regularity. An extremely elegant specimen of this description in my father's collection, is delineated and described by Haidinger, in Brewster's Journal, III. 63. Others form translucent hair-like fibres, and some are quite filamentous. At St Yrieix in France, and in Castile, it forms remarkable geniculated twin crystals, which are often of large size. At Ohlapian in Transylvania, it is met with in pebbles, which from their black colour are denominated *nigrine*; and at Arendal in Norway it occurs massive, associated with pistazite in veins of magnetic iron. There is another massive variety, the *titan oxydé chromifère* of Haüy, which accompanies tourmaline at Karingbricka in Sweden, and is said to contain about three per cent. of chrome. The oxide of titanium is used in painting porcelain. Small cubical crystals of metallic titanium, found among the iron slags in Wales, have been described by Dr Wollaston in the Philosophical Transactions for 1823; and similar crystals have since been remarked in certain slags from Silesia and Swabia.

## ANATASE.

Pyramidal Titanium Ore, *M.* Octahedrite, *J.* Anatase, *P.* Oktaedrit, *W.* Anatas, *L.* Titane Anatase, *H.*

Sp. Gr. 3.8—3.9. H. = 5.5—6.0.

Pyramidal. FIG. 136. Inclination of  $P$  to  $P = 97^\circ 56'$ , of  $P$  to  $P' = 126^\circ 22'$ . Colour various shades of brown, passing into indigo-blue; having a greenish-yellow colour by transmitted light. Transparent, translucent, and opaque. Lustre metallic-adamantine. Streak white. Cleavage perfect, both parallel to  $P$ , and perpendicular to the axis. It consists, like the foregoing species, of pure oxide of titanium; and before the blowpipe comports itself like that substance.

## OBSERVATIONS.

The principal locality of anatase is Bourg d'Oisans in Dauphiné, where it accompanies felspar, quartz, axinite, and crichtonite. It is also found disposed in mica slate in the Grisons; at Tavatsch in the Tyrol; and in Brazil, both imbedded in quartz and in detached crystals, which so much resemble diamond in colour and general appearance, that they are not unfrequently confounded with it by lapidaries and mineral dealers. When heated, it exhibits a reddish-yellow phosphorescent light, which appears suddenly like a flame, and is soon over, a peculiarity, according to Sir D. Brewster, not met with in other species. The collection at Paris contains some magnificent crystals of anatase.

## BROOKITE.

Prismatic Titanium Ore, *Haid.* Brookite, *Levy.*

H. = 5.5—6.0.

Prismatic. FIG. 137. Inclination of  $e$  to  $e = 101^\circ 37'$ , of  $e$  to  $e'$  on the opposite side =  $135^\circ 46'$ , of  $m$  to  $m$  over  $h = 140^\circ$ . Colour hair-brown, passing into deep orange-yellow, and some reddish tints. Translucent or opaque. Lustre metallic-adamantine. Streak yellowish-white. Brittle. Contains titanium, but has not yet been analysed.

## OBSERVATIONS.

This species was first observed by M. Soret of Geneva, accompanying anatase from Dauphiné; but much finer crystals, some of them half an inch in diameter, have latterly been described by Levy, from Snowdon in Wales. The Tête-noir in Savoy is another locality, where it is known under the name of *titane brookite*; but it is not a common mineral at any of these places.



## RED OXIDE OF ZINC.

Prismatic Zinc Ore, *M.* Red Zinc, or Red Oxide of Zinc, *J.* Zinkoxyd, *L.* Zinc Oxidé Ferrifère Lamellaire Brun Rougeatre, *H.*

Sp. Gr. 5.4—5.5. H. = 4.0—4.5.

Prismatic. *Colour* red, of various hues, inclining to yellow. Translucent on the edges. *Lustre* adamantine. *Streak* orange-yellow. *Cleavage* in two directions, forming an angle of about 120°. *Fracture* conchoidal. Brittle and easily scratched with the knife. It contains

Oxide of zinc	92.0	88.0
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Oxides of iron and mang.	8.0 Bruce.	12.0 Berthier.
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Becomes dull on exposure, and assumes a white coating. Alone before the blowpipe it is infusible, but with borax yields a yellow transparent glass. It is soluble without effervescence in nitric acid, and is supposed to derive its red colour from an admixture of manganese.

## OBSERVATIONS.

Red oxide of zinc has not been met with crystallized, but occurs massive, mixed with calc-spar and franklinite, at Sparta in New Jersey. Being found in considerable quantity, it bids fair to become an useful ore of zinc. Mitscherlich has noticed some minute six-sided prisms, formed artificially in the iron furnaces of Königshutte in Silesia, which he supposes to belong to this species.

## RED COPPER ORE.

Octahedral Copper Ore, *M.* Octahedral Red Copper Ore, *J.* Red Oxide of Copper, Oxydulated Copper, *P.* Rothkupfererz, Ziegelerz, *W.* Kupferroth, Kupferbraun, *Haus.* Cuivre Oxidé Rouge, Cuivre Oxidulé, *H.*

Sp. Gr. 5.6—6.1. H. = 3.5—4.0.

Tessular. Octahedron. *Colour* red, of various shades, particularly cochineal-red; occasionally crimson-red by transmitted light. Semi-transparent or translucent. *Lustre* adamantine or imperfect metallic. *Streak* several shades of brownish-red, and shining. *Cleavage* parallel to the faces of the octahedron, but much interrupted. *Fracture* conchoidal or uneven. Brittle.

Siberia.

Cornwall.

Consists of Copper

91.0

88.5

Oxygen

9.0 Klaproth.

11.5 Chenevix.

It is the pure protoxide, which, according to the chemical formula, contains 88.78 copper, and 11.22 oxygen. Before the blowpipe on charcoal it is reduced, and with borax fuses readily into a fine green glass. When pulverized and thrown into nitric acid, a violent effervescence ensues, the solution acquires a green colour, and the copper is dissolved; but in muriatic acid it is soluble without effervescence. It may thus be distinguished from red silver ore, which does not effervesce in nitric acid, and from cinnabar, which does not dissolve in it.

## OBSERVATIONS.

Particularly translucent varieties of this species, presenting numerous interesting modifications of the octahedron, occur with native copper and quartz in Wheal Gorland, and other Cornish mines. Isolated crystals, sometimes an inch in diameter, are met with, imbedded in lithomarge, at Chessy, near Lyons, generally coated or intimately mixed with the green and blue carbonates; and many splendid specimens are brought from Moldawa in the Bannat, and Ekatharineburg in Siberia.

*Capillary red copper* is the same substance in extremely slender crystals, reticulated or variously aggregated, so as sometimes to appear fibrous or flocculent. Its principal localities are Cornwall, and Rheinbreitbach on the Rhine, where it presents bright scarlet colours and a silky lustre. The term *tile ore* is applied to the earthy varieties; they are externally of a brick-red or reddish-brown colour, frequently mixed with oxide of iron, and occur in the Bannat, at Camsdorf and Saalfeld in Thuringia, and in Cornwall. When found in sufficient quantity, it is one of the most valuable ores of copper.

Vessels and other articles made of copper, after long exposure, become to a great extent converted into red oxide, coated with the carbonate sometimes in a crystalline state.

## TIN ORE.

Pyramidal Tin Ore, *M.* and *J.* Oxide of Tin, *P.* Kornisch Zinerz, Zinstein, *W.* Zinerz, *L.* Etain Oxydé, *H.*

Sp. Gr. 6.3—7.1. H. = 6.0—7.0.

Pyramidal. FIG. 113; same as zircon. Four-sided prisms, terminated by four-sided pyramids. Colour principally brown or black, sometimes red, grey, white, or yellow. Varying from almost transparent to opaque. Lustre adamantine. Streak grey



or pale brown. *Cleavage* indistinct. *Fracture* imperfect conchoidal. Brittle. Consists of

	Cornwall.	Spain.
Oxide of tin	99.00	95.0
Oxide of iron	0.25	5.0
Silica	0.75 Klaproth.	0.0 Descotils.

Its chemical proportion if pure being 78.67 tin, and 21.33 oxygen. It is reducible on charcoal when exposed for some time to the blowpipe, but is insoluble in acids. Its superior hardness, and the lighter colour of its streak, distinguish it from Wolfram.

#### OBSERVATIONS.

The oxide of tin generally occurs either crystallized or fibrous, rarely massive. It belongs almost exclusively to primitive mountains, and is met with in veins traversing granite, gneiss, and mica slate.

The finest and most remarkable simple crystals are found in Cornwall, accompanying quartz, fluor spar, apatite, topaz, blende, wolfram, &c. while those which are most noted for their macled structure are brought from the mining districts of Bohemia and Saxony. Generally speaking, the Cornish varieties are not of large size, though extremely perfect in form and symmetry; while the twin-crystals of Zinnwald and Schlackenwald are often of considerable magnitude, and weigh several pounds. No country however affords it in such profusion as Cornwall, where, as is well known, it was worked at a period anterior even to the Romans. It is there met with under a great variety of forms, different veins yielding different crystallizations. Moreover, when accompanied with copper, it usually appears nearer the surface; and thus many of the abandoned tin mines of the Romans have yielded rich store of copper to modern miners. Besides the different localities of the Erzgebirge, it occurs in Galicia, in the department of the Haute Vienne in France, in Greenland, Sweden, the United States, and in the peninsula of Malacca, and the island of Banca in Asia. Some Swedish varieties from Broddbo and the vicinity of Fahlun, where they occur in small octahedral crystals, associated with pyrophysalite, albite, and quartz, have yielded to Berzelius several per cent. of the oxide of tantalum. This is the columbiferous oxide of tin described by Phillips.

*Fibrous* or *wood tin* forms concentric radiated groups, or botryoidal masses of dark-brown and light-fawn colours. In Cornwall it is found in the stream works, in pebbles of considerable size; but the most splendid specimens come from Brazil. *Toad's-eye tin* is the same on a smaller scale. It abounds in several mines near Tregurthy Moor in Cornwall, imbedded in a rock which principally consists of quartz. *Stream tin*, as its name indicates, is the alluvial debris of tin veins, separated from the deposits of gravel, by washing. These deposits occur in the low grounds of Cornwall, and frequently contain animal and vegetable remains, such

as deer-horns, hazel nuts, &c. The ore obtained in this way often yields seventy per cent. of pure tin; and is occasionally associated with grains of native gold. Within these few years an interesting example of pseudo-crystallization has been observed at St Agnes, near the Beacon in Cornwall, where crystals of felspar, which are numerous in that vicinity, have been removed and replaced by oxide of tin. These afford the most regular and perfect forms; and though of a granular and incoherent texture, can never be mistaken for any other substance. Another singular parasitic formation, and from the same vicinity, is that of white oxide of tin assuming the form of quartz. As the ores of tin generally occur disseminated through the rock in minute veins, it is on most occasions necessary to pound the whole mass before they can be smelted; and hence the washing apparatus attached to most tin mines is generally on an extensive scale. Upwards of four thousand tons of tin, amounting in value to about L.300,000, are annually obtained from Cornwall. It is principally used for tinning or covering the surface of iron and copper, particularly such articles as are employed for culinary purposes, to prevent their rapid oxidation when exposed to air and moisture. Pewter is a mixture of tin and lead, in the proportions of from thirty to fifty per cent. of the latter. The presence of the lead in this case is not considered dangerous, as the tin itself is much sooner acted upon by acids which may be contained in such vessels, than the lead which is combined with it. The metallic surface of mirrors is formed of a mixture of tin and mercury; and muriate of tin is an important material in the process of dyeing.

Pure metallic tin much resembles silver; but is easily distinguished from that metal, by the peculiar crackling noise which it makes on being bent.

#### WOLFRAM.

Prismatic Scheelium Ore, *M.* Prismatic Wolfram, *J.* Tungstate of Iron, *P.* Wolfram, *W.* and *L.* Schéelin Ferruginé, *H.*

Sp. Gr. 7.1—7.4. H. = 5.0—5.5.

Hemi-prismatic. FIG. 138. Inclination of *t* to *t* over the apex =  $125^{\circ} 20'$ , of *r* to *r* over *M* =  $101^{\circ} 5'$ . Both crystallized and massive. *Colour* dark greyish- or brownish-black. *Opake.* *Lustre* imperfect metallic. *Streak* dark reddish-brown. *Cleavage* perfect parallel to a plane, which bevels the lateral edge between *r* and *r*. It consists, according to Berzelius, of

Tungstic acid	78.77
Protoxide of manganese	6.22
Protoxide of iron	18.32
Silica	1.25

The proportion of its ingredients when pure are (taking them



in the above order) 77.27 : 5.84 : 16.89. It decrepitates before the blowpipe ; but melts, when sufficiently heated, into a black scoriaceous globule. It is pretty easily soluble in borax, and does not affect the magnetic needle.

## OBSERVATIONS.

Wolfram frequently accompanies tin ore, more so indeed than miners desire ; for in some parts of Cornwall it occurs in such abundance, as to make the working of its more valuable associate not worth the expense. In several of the Saxon and Bohemian tin mines, as at Schlackenwald, Zinnwald, Ehrenfriedersdorf, and Geyer, it is found in large well-defined crystals ; also in Greenland, Siberia, at Limoges in France, and in the island of Rona, one of the Hebrides, in gneiss.

At Huel Maudlin in Cornwall it has occurred in pseudomorphic crystals, assuming the precise form of tungsten ; and similar appearances have occasionally been noticed at Schönfeld and elsewhere in Saxony.

## TANTALITE.

Prismatic Tantalum Ore, *J. and M.* Columbite, *P.* Tantalit *of the Germans.* Tantale Oxidé, *H.* Columbite, *Hatchett.*

Sp. Gr. 6.3—6.8. H. = 6.0.

Prismatic. In indistinct crystalline masses, assuming at times the form of four-sided prisms. *Colour* greyish- and brownish-black. *Opake.* *Lustre* imperfect metallic. *Streak* brownish-black. *Cleavage* rather perfect in one direction. Contains

	Bodenmais.	Broddbo.	America.
Oxide of tantalum	75.0	67.6	80.0
Oxide of tin	1.0	8.7	0.0
Oxide of iron	17.0	7.6	15.0
Oxide of manganese	5.0	5.9	5.0
Oxide of scheelium	0.0	8.7	0.0
Lime	0.0 Vogel.	1.5 Berzel.	0.0 Wollas.

Alone it is infusible before the blowpipe ; but is slowly and perfectly soluble in borax, communicating to it a faint green colour. Insoluble in acid.

## OBSERVATIONS.

It occurs in red felspar at Kimito in Finland ; in albite and quartz at Broddbo and Finbo, near Fahlun in Sweden ; and in granite at Bodenmais in Bavaria ; also at Rabenstein, near Zwiesel in Bohemia ; at Haddam in Connecticut ; and in the tourmaline deposit of Chesterfield in Massachusetts, accompanying felspar, beryl, &c.

Nordenskiöld (Jahresbericht for 1833, p. 190), mentions a variety of tantalite from Tamela, which consists of tantalic acid 83·44, oxide of iron 13·75, and oxide of manganese 1·12. Its sp. gr. is 7·26, and its crystalline form prismatic.

### YTTRO-TANTALITE.

Ytthro-Tantalite, *J.* Ytthro-Columbite, *P.* Tantale Oxydé Yttrifère, *H.*

Of this there are three varieties, the *black*, the *yellow*, and the *dark*, each of which requires a particular description.

*Black ytthro-tantalite* exhibits indistinct traces of crystallization. Sp. Gr. 5·3—5·5. H. about 5·5. It is black and opaque, with an imperfect metallic lustre, and grey streak.

*Yellow ytthro-tantalite* is never crystallized, but forms laminæ in the fissures of felspar. Sp. Gr. 5·8—5·9. H. = 5·0. Colour yellowish-brown. Opaque. Lustre resinous on the surface, vitreous in the fracture. Streak white.

*Dark ytthro-tantalite* does not exhibit any trace of crystallization; but occurs with the preceding in thin laminæ. Its sp. gr. has not been determined, but its hardness is 4·5—5·0. Colour black; lustre intermediate between vitreous and resinous; streak white; and when in small fragments translucent, and slightly yellow.

According to Berzelius, these varieties contain the following ingredients:—

	Black.	Yellow.		Dark.
Oxide of tantalum	57·00	59·50	60·12	51·81
Yttria	20·25	24·90	29·78	38·52
Lime	6·25	3·29	0·50	3·26
Oxide of uranium	0·50	8·23	6·62	1·11
Tungstic acid with tin	8·25	1·25	1·10	2·59
Oxide of iron	3·50	2·72	1·20	0·56

They are all by themselves infusible before the blowpipe; but they decrepitate, and acquire a lighter colour. Black ytthro-tantalite froths and melts with soda, but not the others. In borax they are dissolved, forming a yellowish glass; but none of them are acted upon by acids.

#### OBSERVATIONS.

Mineralogists are indebted to Berzelius for the discovery and description of these different varieties. They are all found in Sweden; at Ytterby in red felspar; and at Broddbo and Finbo near Fahlun, imbedded in quartz and albite, and associated with garnet, mica, and pyrophyllite.



## FERGUSONITE.

Fergusonite, *Haid.*

Sp. Gr. 5.8—5.9. H. = 5.5—6.0.

Pyramidal. FIG. 139. Inclination of  $s$  to  $s = 100^\circ 28'$ , of  $s$  to  $s' = 128^\circ 27'$ . Colour brownish-black. Opake, except when in thin splinters. Lustre externally dull, on the fracture brilliantly vitreous. Streak very pale brown. Fracture perfect conchoidal. Contains columbic acid 47.75, yttria 41.91, oxide of cerium 4.68, zirconia 3.02, oxide of tin 1.00, oxide of uranium 0.95, oxide of iron 0.34—Hartwall. (Jameson's Jour. March 1830). It is infusible before the blowpipe, but loses its colour; and with re-agents affords nearly the same results as the preceding species.

## OBSERVATIONS.

This very rare mineral was found by Giesècké, disseminated in quartz, at Kikertaursak, near Cape Farewell in Greenland. The above description and accompanying figure were obtained by Haidinger from specimens presented to my father by the original discoverer. It was named in honour of Robert Ferguson, Esq. of Raith, M. P., whose splendid collection of minerals evinces his zeal for this science.

## URANIUM ORE.

Uncleavable Uranium Ore, *M.* Indivisible Uranium or Pitch Ore, *J.* Uran-Ochre, Pitch Blende, *P.* Pecherz, *W.* Pechuran, *Haus.* Uran-Pecherz, *L.* Urane Oxydulé, *H.*

Sp. Gr. 6.4—6.6. H. = 5.5.

Massive and botryoidal. Colour greyish-, brownish-, or velvet-black. Opake. Lustre dull, or imperfect metallic. Streak black, a little shining. Cleavage unknown. Fracture conchoidal, but uneven. Contains protoxide of uranium 86.5, protoxide of iron 2.5, silica 5.0, sulphuret of lead 6.0—Klaproth.

Alone, it is infusible before the blowpipe, but with borax melts into a grey scoria. If reduced to powder, it is slowly soluble in nitric acid, with a disengagement of nitrous gas. Does not affect the magnet.

## OBSERVATIONS.

Uranium ore is found in botryoidal masses, accompanying various ores of silver and lead, at Johanngeorgenstadt, Marienberg, and Schneeberg,

in Saxony; and at Joachimsthal and Przibram in Bohemia; also at Rez-banya in Hungary; and with uranite in some of the Cornish tin mines.

It is a valuable ore to the porcelain painter, yielding a fine orange colour in the enamelling fire, and a black one in that in which the porcelain itself is baked.

### CERITE.

Rhombohedral Cerium Ore, *M.* Siliferous Oxide of Cerium, Indivisible Cerium Ore or Cerite, *J.* Cerite, *P.* Cerinstein, *W.* Cererit, *L.* Cerium Oxydé Silicifère, Cerium Oxydé Siliceux Rouge, *H.*

Sp. Gr. 4.9—5.0. H. = 5.5.

Rhombohedral. Crystalline form unknown. Massive and amorphous. *Colour* between clove-brown and cherry-red, passing into grey. Slightly translucent on the edges. *Lustre* dull. *Streak* greyish-white. *Cleavage* unknown. *Fracture* splintery.

Contains Oxide of cerium	68.59	67.0
Silica	18.00	17.0
Oxide of iron	2.00	2.0
Lime	1.25	2.0
Water and carb. acid	9.60 Hisinger.	12.0 Vauq.

Alone it does not fuse before the blowpipe, but with borax forms an orange-yellow globule, which becomes almost colourless on cooling.

#### OBSERVATIONS.

The only known locality of cerite is the old copper mine of Bastnaes, near Riddarhyttan in Westmanland, Sweden, where it forms a bed in gneiss, accompanying mica, hornblende, copper pyrites, cerine, &c. It is tough and difficultly frangible, and in colour and appearance bears considerable resemblance to the red granular variety of corundum. Its greatly inferior hardness, however, is sufficiently characteristic.

### CERINE.

Cerine, *Berzelius.* Cerium Oxydé Siliceux Noir, *H.*

Sp. Gr. 4.1—4.2. H. = 5.0—6.0.

Prismatic. Massive, or crystallized in black prisins, which are not easily determinable. *Colour* brownish-black. *Opake.* *Streak* yellowish-grey, inclining to brown. *Cleavage* pretty distinct in a longitudinal direction. Consists of silica 30.17, alumina 11.31, lime 9.12, oxide of cerium 28.19, oxide of iron 20.72, with a little accidental copper. Before the blowpipe it froths,



and melts readily into an opake shining black globule, which acts upon the magnetic needle. With borax it forms a reddish or yellowish-brown, and with a small proportion of soda a dark-greenish-grey globule. Does not affect the magnet.

## OBSERVATIONS.

It occurs associated with the preceding species, and, like it, is only met with at Bastnaes in Sweden. Haüy unites cerine and allanite, their chemical composition being nearly alike.

## CHROMATE OF IRON.

Octahedral Chrome Ore, *M.* Prismatic Chrome Ore, *J.* Chromate of Iron, *P.* Chrom-eisenstein, *W.* Eiseenchrom, *L.* Fer Chromaté, *H.*

Sp. Gr. 4.4—4.5. H. = 5.5.

Tessular. Crystalline form the octahedron. Generally massive. Colour iron-black or brownish-black. Opake. Lustre imperfect metallic. Streak brown. Cleavage imperfect. Fracture uneven. Consists of

	Styria.	Baltimore.
Oxide of chrome	55.5	60.04
Protoxide of iron	33.0	20.13
Alumina	6.0	11.85
Silica	2.0	0.00
Magnesia	0.0 Klaproth.	7.45 Abich.*

It is infusible before the blowpipe; but acts upon the magnet after exposure to the reducing flame. It is difficultly but entirely soluble with borax, and imparts to it a beautiful green colour.

## OBSERVATIONS.

Chromate of iron occurs in irregular veins traversing serpentine, in the Gulsen Mountains near Kraubat in Styria, and in the islands of Unst and Fetlar in Shetland, where it is obtained in sufficient quantity to render it an article of export. Octahedral crystals have been noticed at Baltimore and Hoboken, in New Jersey; but at its other localities, the Department du Var in France, Silesia, Bohemia, the Uralian Mountains, and Greenland, it is only known massive.

Its large proportion of chrome renders this a highly valuable mineral. In combination with the oxides of other metals, it yields green, yellow, and red pigments, which are used in oil-painting, dyeing, and colouring porcelain.

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\* The crystallized variety,—vide Poggendorf, Ann. xxiii. 341.

## TITANITIC IRON.

Axotomous Iron Ore, *M.* Iserine, Menaccanite, *P.* Ilmenit, *L.*

Sp. Gr. 4.4—4.8. H. = 5.0—5.2.

Rhombohedral. FIG. 140. Rarely distinct. *Colour* dark iron-black. *Opake*. *Lustre* imperfect metallic. *Streak* black. *Cleavage* perfect parallel to *o*. *Fracture* conchoidal. Slightly affects the magnetic needle,

	Miask.	Gastein.
Titanitic acid	46.67	59.00
Oxide of iron	47.08	40.25
Ox. of manganese	2.39	1.65
„ Magnesia	0.60	0.00
Lime	0.25	0.00
Oxide of chrome	0.38	0.00
Silica	2.80 Mosander.	0.00 Kobell.

It is infusible before the blowpipe *per se*, but comports itself with fluxes like oxide of iron; and is readily soluble in concentrated muriatic acid.

## OBSERVATIONS.

This species forms irregular crystals and masses, imbedded in serpentine, and associated with apatite and sparry iron at Inglisberg, near Hoff, in the valley of Gastein, Salzburg. It occurs massive and compact at Eggersund in Norway; imperfectly crystallized at Ilmensee and Ekatharineburg, in Siberia, forming the variety termed *ilmenite*; in grains along with rutile at St Yrieux in France; and in rolled masses disseminated through the granitic sand of the river Iser in Bohemia, in the island of St Domingo, &c. It is occasionally accompanied by rutile, forming a coating on the crystals of that mineral. Nigrine, which is a variety of rutile, when in irregular masses has sometimes been mistaken for this; but its inferior hardness and black streak (that of nigrine being pale-brown), are sufficiently characteristic. Different titanitic-iron sands necessarily vary considerably in their proportions of titanic acid and oxide of iron; the analyses which are published of them are consequently little to be depended on. Haidinger connects this species with the following.



## CRICHTONITE.

Crichtonite, *P.* Crichtonite, *Bournon*. Fer Oxydulé Titané, *H.*

Sp. Gr. 4.0. H. = 4.5.

In small acute rhomboids, having their summits replaced. *Colour* black. *Opake*. *Lustre* metallic, very brilliant. *Fracture* conchoidal and shining. Consists, according to Berzelius, of the oxides of iron and titanium. It is infusible before the blowpipe; but with salt of phosphorus affords a glass, which becomes red on cooling. It does not affect the magnet.

## OBSERVATIONS.

Its only locality is St Christophe near Oisans, in the department of the Isère in France, where it occurs in small crystals, along with anatase, quartz, and chlorite.

## MAGNETIC IRON.

Octahedral Iron Ore, *M.* and *J.* Oxydulated Iron, *P.* Magneteisenstein of the Germans. Fer oxydulé, *H.*

Sp. Gr. 4.8—5.2. H. = 5.5—6.5.

Tessular. Octahedron. *Colour* iron-black. *Opake*. *Lustre* metallic, sometimes imperfect. *Streak* black. *Cleavage* parallel to the faces of the octahedron; in some varieties perfect, in others entirely obliterated by conchoidal fracture. *Fracture* conchoidal and shining. It is highly magnetic, especially when massive, more so than any other ore of iron. It consists entirely of iron and oxygen in the proportion, according to Berzelius, of two atoms peroxide, to one protoxide. It contains 28.21 per cent. of oxygen. Before the blowpipe it becomes brown, and loses its influence on the magnet; but does not fuse. It is soluble in heated muriatic, but not in nitric acid. From specular iron it is distinguished by its streak and action on the magnet.

## OBSERVATIONS.

The extensive beds at Arendal in Norway, and almost all the celebrated iron mines of Sweden, consist of massive magnetic iron. Dannemora, Gellivara, and the Taberg in Småland, a mountain of considerable dimensions, are entirely formed of it, immense quantities being annually obtained from these localities, and the iron exported in bars. Generally it is the product of primitive countries, where it forms beds and large irregular masses, accompanying hornblende, asbestos, garnet, calcareous spar, &c. Such are the repositories of Dannemora-iron; these are exca-

vated to the day, the principal mine forming a vast chasm of about 150 feet broad, and nearly 500 deep. This ore affords about 60, sometimes even 80 per cent. of iron, and is accompanied by calcareous spar, to the chemical action of which during smelting, is attributed its quality of producing such excellent steel. The iron mines of Uton are of a similar description. The Taberg in Småland, again, is a distinct mountain, rising abruptly from the south, to the height of 420 feet, and inclining gradually for more than a mile to the north; it consists of greenstone, which contains from 20 to 30 per cent. of iron; and being on that account considered worth the smelting, is removed *en masse* as an iron ore. The mountains of Kurunavara and Gellivara, in Lapland, are on a still more extensive scale; their difficulty of access, however, has hitherto prevented them becoming important as mining districts. Large isolated octahedrons of magnetic iron are found imbedded in chlorite-slate at Fahlun, in Sweden; smaller individuals in the island of Corsica; with gmelinite in the cavities of amygdaloid, in the island Magee, county Antrim; very resplendent dodecahedral crystals at Normark, in Wermeland; dull ones of the same form at Traversella, in Piemont; and not unfrequently, in interesting modifications, among the ejected masses of Mount Vesuvius. Smaller quantities occur both on the continent of Europe, and in America; and most lavas contain considerable portions of iron.

Siberia and the Hartz produce the most powerful natural magnets. These usually present amorphous masses; and, though distinguished by the older mineralogists, evidently belong to the present species. They attract iron filings, and exhibit polarity, their different extremities attracting and repelling the magnetic needle in the same manner as a second needle would; a property which, though perceptible only in a few varieties of magnetic iron, is supposed to exist in all of them.

### FRANKLINITE.

Dodecahedral Iron Ore, *M.*

Sp. Gr. 5·0—5·1. H. = 6·0—6·5.

Tessular. FIG. 141. Combination of the octahedron, dodecahedron, and cube. In granular masses composed of imperfect crystals. *Colour* iron-black. *Opake*. *Lustre* metallic. *Streak* dark-brown. *Cleavage* indistinct. *Fracture* conchoidal. Acts slightly on the magnet. Contains

Peroxide of iron	66·0	66·10	68·86
Oxide of zinc	17·0	17·43	10·81

Red ox. of mangan. 16·0 Berthier. 14·96 Thoms. 18·17 Abich. with a little silica and magnesia. This corresponds to the chemical formula expressive of 17·2 oxide of zinc, 15·7 oxide of manganese, and 67·1 peroxide of iron. It is soluble without



effervescence in heated muriatic acid. At a high temperature the zinc is driven off, and a hard compound of iron and manganese remains.

## OBSERVATIONS.

Franklinite is a rare mineral. Its best known locality is Sussex county, in New Jersey, where it occurs associated with red oxide of zinc, and imbedded in calcareous spar. It is mentioned also, as accompanying ores of zinc, in amorphous masses, at the mines of Altenberg, near Aix-la-Chapelle. It may be distinguished from the last species by its streak.

## SPECULAR IRON.

Rhombohedral Iron Ore, *M.* Rhomboidal Iron Ore, *J.* Specular Iron, Red Iron Ore, *P.* Eisenglanz, Rotheisenstein, *W.* Blutstein, *Haus.* Eisenoxyd, *L.* Fer Oligiste, Fer Oligiste Concretionné, *H.*

Sp. Gr. 4.8—5.3. H. = 5.5—6.5.

Rhombohedral. FIG. 142. *Colour* dark steel-grey, or iron-black. *Opake*, except when in very thin laminæ, which are faintly translucent, and of a deep blood-red tinge. *Lustre* metallic. *Streak* cherry-red, or reddish-brown. *Cleavage* parallel to *o* and *P*, though in some varieties scarcely perceptible. Sometimes acts feebly upon the magnet; and the volcanic varieties occasionally exhibit polarity. Specular iron, when pure, consists solely of peroxide of iron, the proportion of metal to that of oxygen being as 69.34 to 30.66; frequently it contains a little titanium. D'Aubuisson found in Red hematite peroxide of iron 94.0, silica 2.0, lime 1.0, water 3.0.

*Per se* it is infusible before the blowpipe, but melts with borax, and forms a green or yellow glass, like pure oxide of iron. It dissolves in heated muriatic acid. It is distinguished from magnetic iron by its streak.

## OBSERVATIONS.

Mineralogists have differed much respecting the identity of red iron ore and specular iron; but, except in external appearance, and a slight diversity in their chemical composition, they can only be considered varieties of the same species. The principal cause of this difference is in the size of their component parts; specular iron consisting of such as are at least distinguishable, while red iron ore is produced by a congeries of extremely small individuals, which cannot be distinguished from each other. *Specular iron* applies peculiarly to such varieties as have a perfect metallic appearance; while those of thin lamellar structures are denominated *micaceous specular iron*. Red iron presents several varieties:

*Fibrous red iron* or *red hematite* (the *rother glaskopf* of Werner, and *fer oligiste concretionné* of Haüy); it occurs in reniform masses, and consists of columnar particles of composition, which sometimes exceed a foot in length: *Compact* and *ochrey* red iron ores are massive, and consist of impalpable granular individuals more or less firmly connected; and *Scaly* red iron ore, or *red iron froth*, consists of small scaly laminæ, which in most cases are but slightly coherent. Under this head are also enumerated the different *clay iron ores*, many of which contain comparatively small portions of iron; the drawing material called *reddle* or red chalk, which possesses an earthy or coarse slaty fracture; *jaspery clay iron*, having a large and flat conchoidal fracture; and *columnar* and *lenticular clay iron*, which are distinguished by their columnar or flattish granular composition. These last are principally from the circles of Leitmeritz and Elbogen, in Bohemia. The most remarkable repository of specular iron is Elba, the "*Insula inexhaustis chalybdom generosa metallis*," where it has been worked from the earliest periods, and where it is still obtained in considerable quantity. The surfaces of the splendid crystals from this locality frequently present the most magnificent tarnish-colours; indeed almost universally, except on the face *o*, a peculiarity which it is well to recollect in searching for their true position. Splendid specimens, consisting of large crystalline plates, grouped together in the form of rosettes, accompany crystals of adularia at St Gothard. Very resplendent crystalline plates, sometimes of considerable dimensions, are formed by sublimation in the fissures of lava at Stromboli and Lipari, likewise, though in smaller individuals, at Etna, Vesuvius, and in Auvergne. The Fossa Kankarone on Monte Somma produces large acute four-sided pyramids under similar circumstances. Arendal in Norway, Langbanshyttan in Sweden, Framont in Lorraine, Dauphiné, and Switzerland, also afford splendid varieties of this species; and in many parts of Sweden it occurs massive, compact, and granular.

Red hematite is found in large kidney-shaped masses, formed of concentric fibrous coats, which exhibit occasionally a peculiar hammered-like appearance, near Ulverstone in Lancashire, in Saxony, Bohemia, the Fichtelgebirge, and the Hartz. At Sundvig in Westphalia, it appears in pseudomorphic crystals, which assume the form of calcareous spar. *Iron mica* occurs in small and extremely thin plates; it is translucent, presents a dark-red colour by transmitted light, and is principally known from Cattas Altas in the Brazils. The red streak of this species is at once its easiest and most unerring characteristic, that of magnetic iron being black. All its varieties are of importance to the iron smelter, as a considerable portion of the iron produced in different quarters of the globe is manufactured from them. They require, and particularly the specular varieties, a greater degree of heat than some others; but the metal they afford is nevertheless excellent. Red hematite, when ground to a fine powder, is used for polishing metals, and as a colouring substance.

A century ago there were only fifty-nine iron furnaces in Great Bri-



tain, producing together about 17,000 tons per annum. Now the number is estimated at nearly three hundred, from which we have an annual produce of about 700,000 tons of iron.

### BROWN IRON ORE.

Prismatic Iron Ore, *M. and J.* Hydrous Oxide of Iron, Brown Iron Ore, Brown Hematite, *P.* Brauneisenstein, Thoneisenstein, *W.* Eisenoxyd-Hydrat, *L.* Fer Oxydé, *H.* Fer Hydro-Oxidé, *Levy.*

Sp. Gr. 3·8—4·2. H. = 5·0—5·5.

Prismatic. In flat sharp-pointed crystals; generally in globular or stalactitic shapes. *Colour* various shades of brown, commonly dark. Crystals often semi-transparent, and exhibiting a blood-red tint; other varieties nearly opaque. *Lustre* adamantine. *Streak* yellowish-brown. *Cleavage* pretty distinct, parallel to the broad faces of the crystals. Does not act on the magnet. Consists, according to D'Aubuisson, of

	<i>Hematitic.</i>	<i>Compact.</i>
Peroxide of iron	82·0	84·0
Water	14·0	11·0
Oxide of manganese	2·0	2·0
Silica	1·0	2·0

It is a hydrate of peroxide of iron; the proportions of peroxide of iron and water being as 85·30 to 14·70. Before the blowpipe it becomes black and magnetic, and with borax fuses into a green or yellow glass. It is soluble in warm nitro-muriatic acid; and gives off water when heated in the matrass.

#### OBSERVATIONS.

This mineral presents even greater diversity of external appearance than the last. It is found both crystalline and massive. The crystals small, externally black, and very brilliant; by transmitted light of a brownish hue. The massive,—better known under the appellation of brown hematite,—is usually fibrous and radiating; it assumes externally stalactitic or botryoidal forms, and internally a silky lustre and brownish tinge; its colours being frequently disposed in concentric rings of various shades.

Crystallized it is comparatively of rare occurrence, being found with quartz in the cavities of sandstone at Clifton near Bristol, in perfect black and highly brilliant crystals near Lostwithiel in Cornwall, and disposed in groups at Lake Onega in Siberia. This variety has received the trivial names of *onegite*, *rubin-glimmer*, *pyrrhosiderite*, and *göthite*; the first from its locality, and the last in honour of the celebrated German poet and mineralogist, Göthe. Reniform and fibrous varieties occur principally

in Cornwall, at Clifton, at Sandloge in Shetland, in Carinthia, and Bohemia. Stalactitic and radiated, at Siegen near Bonn, Villa Ricca in Brazil, and Vermont in the United States, where the surfaces of the individuals are extremely black, and present a brilliant shining lustre. *Scaly* and *ochery brown iron*, are varieties of the same species more or less decomposed, presenting either slightly cohering scales and particles, or having an earthy consistence which is meagre to the touch, and soils the fingers. *Bog iron ore*, the *morasterz*, *sumpferz*, *wiesenerz* of the Germans, is of recent formation; it arises from the decomposition of certain rocks over which water passes, and is deposited by it in low and marshy situations. It frequently contains traces of phosphoric acid, and forms considerable repositories in Germany, Poland, and Russia. The variety termed *bohnerz* or *pea-ore*, consists of concentric globuliform concretions, imbedded either in friable, or compact brown hematite. At St Stephens in Styria, this kind of ore yields about 33 per cent. of iron. Brown iron ore not unfrequently assumes the form of other minerals; at Huttenberg in Carinthia, for instance, it has evidently taken the place of sparry iron; and at Beresof in Siberia occupies large cubical pseudocrystals of iron pyrites.

As an ore it is not inferior in value to any of the preceding; and the pig-iron, obtained from smelting its purer varieties with charcoal, may be easily converted into steel. That yielded by bog-iron is what is termed *cold short*; it therefore cannot be used in the manufacture of wire, and seldom even of sheet or plate iron, though it is well adapted for casting.

#### LIEVRITE.

Di-prismatic Iron Ore, *M. Lievrite*, *J. Yenite*, *P. Lievrit*, *W. Ilvait*, *Haus. Yenite*, *Fer Calcareo-Siliceux*, *H.*

Sp. Gr. 3·8—4·1. H. = 5·5—6·0.

Prismatic. FIG. 143. Inclination of *o* to *o* =  $139^{\circ} 37'$ , of *o* to *o'* on the other side =  $117^{\circ} 38'$ , of *o* to *M* =  $128^{\circ} 38'$ , of *M* to *M* =  $112^{\circ} 37'$ . The faces of the prism deeply striated longitudinally. Colour iron-black, or dark greyish-black. Opake. Lustre imperfect metallic. Streak black, inclining to green or brown. Cleavage not very distinct. Fracture uneven.

Contains Oxide of iron	55·0	52·54
Silica	28·0	29·28
Lime	12·0	13·78
Ox. of manganese	3·0	1·58
Alumina	0·6	0·00
Water	0·0	Descotils. 1·27 Stromeyer.

Before the blowpipe it fuses without effervescence into an opake glass, which is magnetic; and with borax forms a yellow-



ish-green globule. It is soluble in muriatic acid ; and acts upon the magnetic needle after exposure to heat.

## OBSERVATIONS.

The principal locality of Lievrite is the Rio la Marina in Elba, where it is found both in solitary crystals of considerable dimensions, and imbedded in compact augite. It has been noticed also at Fossam in Norway, in Siberia, Silesia, and North America. The name yenite or jenite, was applied to it by the French mineralogists, in commemoration of the battle of Jena in 1806 ; that of lievrite, in compliment to its discoverer.

The public collection of natural history at Florence is extremely rich in specimens of this mineral.

## POLYMIGNITE.

*Berzelius, Brewster's Jour. III. 329.*

Sp. Gr. 4.77—4.85. H. = 6.5.

Prismatic. FIG. 145. In long thin prisms, the edges of which are commonly replaced. Colour black. Opake. Lustre imperfect-metallic, but brilliant. Streak dark-brown. Traces of cleavage parallel to T and M. Fracture perfect-conchoidal, presenting, like the surface, a brilliancy almost metallic. Surfaces of the crystals deeply striated longitudinally. Berzelius found it to consist of titanitic acid 46.30, zirconia 14.14, oxide of iron 12.20, lime 4.20, oxide of manganese 2.70, oxide of cerium 5.00, yttria 11.50, with traces of magnesia, potash, silica, and oxide of tin. Alone it suffers no change before the blowpipe ; but with borax fuses easily into a glass coloured with iron. When more borax is added, it becomes opake, and of an orange colour.

## OBSERVATIONS.

Polymignite was discovered by Mr Tank of Frederickshall, imbedded in the felspar or syenite of Stavearn and Frederickswarn in Norway. Its crystals are thin, and sometimes exceed an inch in length. The above analysis and description were given by Berzelius, who derived its name from *πολύς*, much, and *μικνύω*, I mix, in allusion to its numerous constituents.

## STILPNOSIDERITE.]

Stilpnosiderite, J. and P. Stilpnosiderit, L.

Sp. Gr. 3.6—3.65. H. = 4.5.

Massive. Botryoidal groups. Composition impalpable. Colour dark brown, or brownish-black. Opake. Streak yellowish-

brown. *Lustre* resinous. *Fracture* conchoidal. Brittle and easily frangible. Contains

Oxide of iron	80.50	80.25
Water	16.00	15.00
Silica	2.25 Ullman.	3.75 Vauquelin.

It becomes black before the blowpipe, but does not fuse ; and tinges borax dark olive-green, though it is not melted itself.

## OBSERVATIONS.

It occurs at Scheibenberg and Rashau in Saxony, in Thuringia, Nassau, and the Hartz, frequently associated with brown hematite. It was described by Ullman, and appears to be allied to certain varieties of brown iron ore.

## HAUSMANNITE.

Pyramidal Manganese Ore, *M.* Foliated Black Manganese Ore, *J.* Black Manganese, *P.* Schwartzer-Braunstein, *W.* Blattriger Schwartz-Braunstein, *Haus.* Schwarz-Manganerz, *L.* Manganèse Oxydé Hydraté, *H.*

Sp. Gr. 4.7—4.8.  $H. = 5.0—5.5.$

Pyramidal. Isosceles four-sided pyramid, whose angles are equal to  $105^{\circ} 25'$  and  $117^{\circ} 54'$ . *Colour* brownish-black. *Opake.* *Lustre* imperfect-metallic. *Streak* chesnut brown. *Cleavage* rather perfect, parallel to the base of the pyramid. *Fracture* uneven. It is an anhydrous red oxide of manganese, consisting, according to Turner, of red oxide 98.10, oxygen 0.21, water 0.43, baryta 0.11, silica 0.34. It is soluble in heated sulphuric acid, yielding a faint odour of chlorine ; and in the oxidating flame of the blowpipe, affords, like other ores of manganese, a fine amethyst-coloured globule.

## OBSERVATIONS.

It has been found in veins of porphyry, along with several of the following species, at Oehrenstock near Ilmenau in Thuringia, at Ihlefeld in the Hartz, and in the United States. The most perfect crystallized specimens are met with at Framont in Alsatia ; but it is on the whole not a common mineral.

## BRAUNITE.

Brachytypous Manganese Ore, *M.* Brachytypous Manganerz, *L.*

Sp. Gr. 4.8—4.9.  $H. = 6.0—6.5.$

Pyramidal. Four-sided pyramid of  $109^{\circ} 53'$  and  $108^{\circ} 39'$  ; occasionally truncated. *Colour* dark brownish-black. *Lustre*



imperfect-metallic. *Streak* black or slightly brownish. *Cleavage* distinct parallel to the faces of the pyramid. *Fracture* uneven. Brittle. It dissolves in muriatic acid, leaving a trace of siliceous matter. Turner, who considers it an anhydrous deut-oxide of manganese, found in the Elgersburg variety protoxide 86.94, oxygen 9.85, water 0.95, and baryta 2.26.

## OBSERVATIONS.

This species was named by Turner and Haidinger, in compliment to their mutual friend Mr Braun of Gotha. It occurs both crystalline and massive, in veins traversing porphyry, at Oehrenstock near Ilmenau, at Elgersburg, Friedrichsroda, and elsewhere in Thuringia; also with red epidote, at St Marcel in Piemont.

Besides its superior hardness to other ores of manganese, the direction of its cleavage parallel to the faces of the pyramid sufficiently distinguishes this species from hausmannite, in which the cleavage always takes place parallel to the base.

## PSILOMELANE.

Uncleavable Manganese Ore, *M.* Compact and Fibrous Manganese Ore, or Black Hematite, *J.* Compact Grey Oxide of Manganese, Black Iron Ore, *P.* Schwarzeisenstein, *W.* Fasriger und Dichter Schwartzbraunstein, *Haus.* Dichtes Schwarz-Manganerz, *L.* Manganese Oxidé Hydraté Concretionné.

Sp. Gr. 4.0—4.15. H. = 5.0—6.0.

Regular form unknown. Massive and botryoidal. *Colour* black, passing into dark steel-grey. *Lustre* imperfect metallic. *Opake.* *Streak* brownish-black, shining. No cleavage. *Fracture* not observable. Though this ore has been placed by mineralogists among the oxides of iron, under the names of black hematite and black iron ore, pure fragments of it do not contain a trace of that metal. Turner's analysis affords the following results: Red oxide 69.79, oxygen 7.36, baryta 16.36, silica 0.26, water 6.22. It colours glass of borax violet-blue, like other manganese ores, and is completely dissolved in muriatic acid, with the exception of a very small quantity of silica.

## OBSERVATIONS.

Though not met with in large repositories, this species is nevertheless one of the most widely diffused ores of manganese. It is frequently associated with pyrolusite, sometimes even alternating with it in layers of different thickness; and occurs in botryoidal and stalactitic-shaped masses in Devonshire and Cornwall; at Ihlefeld in the Hartz; in the district of Siegen in Hessa; and at several places in Saxony, Silesia, and Bay.

reuth. From its mammillated and kidney-shaped appearance, it has obtained the inappropriate designation of *black hematite*; and the title of psilomelane, from  $\psi\iota\lambda\acute{o}\varsigma$ , *smooth* or *naked*, and  $\mu\epsilon\lambda\acute{\alpha}\varsigma$ , *black*, arises, as well as the German name *schwarzer glaskopf*, from its black colour and smooth botryoidal shapes. The manganèse oxidé noir barytifère, from Romanèche, has a somewhat higher specific gravity, but in other respects resembles the present species.

### GREY MANGANESE.

Prismatoidal Manganese Ore, *M. Manganite*, *Haid.* Prismatic Manganese Ore, or Grey Manganese Ore, *J. Grey Oxide of Manganese*, *P. Grauer-Braunstein*, *W. Grau-Braunstein*, *W. Gewassertes Mangan Hyperoxidul*, *L. Manganese Oxydé*, *H. Hydrated Deutoxide of Manganese*, *Turner.*

Sp. Gr. 4.3—4.4. H. = 4.0—4.2.

Prismatic. FIG. 144. Inclination of  $d$  to  $d$  over the apex =  $114^{\circ} 19'$ ; of  $M$  to  $M$  =  $99^{\circ} 40'$ ; of  $s$  to  $s$  contiguous =  $103^{\circ} 24'$ . Colour dark steel-grey or iron-black. Opake. Lustre metallic. Streak reddish-brown. Brittle. Cleavage highly perfect, parallel to a face which bevels the edge  $x$ ; less distinct parallel to  $M$ , or perpendicular to the axis. Fracture uneven. Surface of the crystals deeply furrowed longitudinally. Ihlefeld.

Contains	Red oxide of mangan.	86.85	87.1
	Oxygen	3.05	3.4
	Water	10.10 Turner.	9.5 Gmelin.

Before the blowpipe it does not melt, but with borax yields a violet-blue globule. It is insoluble in nitric acid; but in muriatic, it gives off chlorine, and dissolves without residue. When strongly heated *per se*, it yields oxygen; and in a tube, water is disengaged. It is distinguished from pyrolusite by its superior hardness and characteristic brown streak, which sometimes appears black, until a portion has been abraded.

### OBSERVATIONS.

This is the purest and most beautifully crystallized ore of manganese. It occurs principally at Ihlefeld in the Hartz, associated with calcareous spar and barytes, in veins traversing porphyry; likewise, though less abundantly, in Bohemia, Alsatia, Saxony, and Aberdeenshire. It is highly useful in the manufacture of glass; and is essential in bleaching, and other chemical operations. The grey oxide from Undenaes in West Gothland, analysed by Arfwedson, is a similar compound.



## PYROLUSITE.

Prismatic Manganese Ore, *M.* Anhydrous Peroxide of Manganese, *Turner.*

Sp. Gr. 4.6—4.9. H. = 2.0—2.5.

Prismatic. FIG. 146. Inclination of *M* to *M* over *v* = 93° 40'. Colour iron-black, sometimes bluish. Opake. Lustre metallic. Streak black. Soils. Cleavage parallel to *M*, *v*, and *W*.

Contains Red oxide	84.05	85.62
Oxygen	11.78	11.60
Water	1.12	1.56
Baryta	0.53	0.55
Silica	0.51 Turner.	0.66 Turner.

With borax it fuses before the blowpipe into an amethystine globule, but yields no water when heated in the matrass.

## OBSERVATIONS.

The name pyrolusite alludes to a property which renders this the most valuable of all the ores of manganese. It is derived from *πῦρ*, *fire*, and *λουω*, *I wash*; being employed, in consequence of the large quantity of oxygen which it gives off at a red heat, to discharge the brown and green tints in glass, produced by carbonaceous matter and protoxide of iron. The French have hence fancifully termed it *le savon des verriers*. In an economical point of view, pyrolusite is the ore of manganese properly so called, and is extensively worked in many countries, particularly at Ilmenau, Friedrichsroda, Elgersburg, and other places in Thuringia. The mines of Ehrendorf, near Maehrisch Triebau in Moravia, afford annually many hundred tons of this ore; and in Cornwall, Devonshire, Saxony, France, Hungary, and other countries, it is of more or less frequent occurrence. In all these localities it is associated with psilomelane, from which, however, it is easily distinguished by its greatly inferior hardness; indeed it is generally so soft, as, even in crystalline specimens, to soil the finger when handled. At first sight it may be confounded with certain crystallized varieties of antimony; but its dark steel-grey colour is sufficiently characteristic; and if not, the blowpipe will distinguish it, pyrolusite being perfectly infusible, while antimony yields even to the flame of a candle.

For a detailed description of these ores of manganese, see Haidinger's and Turner's valuable papers in the eleventh volume of Edin. Royal Soc. Trans.

## ORDER METAL.

### ARSENIC.

Native Arsenic, *M. J.* and *P.* Gediegen Arsenik, *W.* Arsenic Natif, *H.*

Sp. Gr. 5·7—5·8.  $H. = 3·5$ .

Rhombohedral. FIG. 42. Massive, or in reniform concretions. *Colour* tin-white, which tarnishes in a few hours to dark grey. *Lustre* metallic. *Streak* unchanged, and rather shining. *Cleavage* parallel to the face *o*. John found in two specimens from Joachimsthal

Arsenic	96·0	97·0
Antimony	3·0	2·0
Iron and water	1·0	1·0

Before the blowpipe it fuses readily, burns with a bluish flame, gives off dense white arsenical vapours, and when pure is entirely volatilized.

#### OBSERVATIONS.

Native arsenic usually occurs in the veins of primitive mountains, associated with red silver ore, realgar, blende, and other metallic minerals. It is common in the Saxon silver mines of Freyberg, Annaberg, and Schneeberg; also at Joachimsthal in Bohemia, at Andreasberg in the Hartz, at Kapnick in Transylvania, at Orawitza in the Bannat, at Zmeoff in Siberia in large masses, and at St Marie aux Mines in Alsace. It is at once distinguished by the facility with which it volatilizes, as well as by the odour and copious white fumes which it emits when exposed to the blowpipe, or thrown upon ignited charcoal. This odour is also distinctly disengaged when the specimen is struck with a steel.

Its effects as a violent poison are well known; but it is notwithstanding made use of in several pharmaceutical preparations, and is variously employed in metallurgical processes.



## TELLURIUM.

Native Tellurium, *M.* and *P.* Hexahedral Tellurium, *J.* Gediegen Silvan, *W.* Gediegen Tellur, *Haus.* and *L.* Tellure Natif Ferrifère et Aurifère, Tellure Natif Auro-Ferrifère, *H.*

Sp. Gr. 6.1—6.2. H. = 2.0—2.5.

Form unknown. Massive and granular. Colour tin-white. Lustre metallic. Streak unchanged. Cleavable in various directions, which, from the minuteness of the individuals, have not been ascertained. Easily frangible.

Contains Tellurium	92.55
Iron	7.20
Gold	0.25 Klaproth.

It fuses readily upon charcoal before the blowpipe, burning with a greenish flame, and volatilizing almost entirely in white vapours.

## OBSERVATIONS.

This very rare mineral occurs in sandstone at the mine of Maria Loretto at Facebay, near Zalathna in Transylvania. It accompanies quartz, iron-pyrites, and gold; has never been met with perfectly pure; and is smelted along with gold ore, in order to extract the small proportion of precious metal which it contains.

## ANTIMONY.

Rhombohedral Antimony, *M.* Dodecahedral Antimony, *J.* Native Antimony, *P.* Gediegen Antimon, Oder Spiesglas, *W.* Gediegen-Spiessglanz, *Haus.* Antimoine Natif, *H.*

Sp. Gr. 6.5—6.8. H. = 3.0—3.5.

Rhombohedral. FIG. 147. Inclination of *P* to *P* = 117° 15'. Rarely crystallized, except from fusion. Massive. Structure lamellar. Colour tin-white, slightly tarnishing on exposure. Lustre metallic. Streak unchanged. Rather brittle. Cleavage highly perfect, and possessing a strong lustre parallel to *o*; also parallel to *P*, but with a minor degree of lustre. Consists of antimony, with small portions of iron, silver, and arsenic.

Its comportment before the blowpipe is very peculiar, melting quickly into a globule, and continuing to burn, when heated to redness, even if the blast be suspended. After sufficient exposure it is volatilized, the white fumes which are given off being deposited round the globule. When observed with the microscope, yellowish-white octahedrons, probably of antimonious acid,

are first formed, and then snow-white prismatic crystals of oxide of antimony, with which at last the whole globule is covered. It crystallizes readily from fusion, is destitute of ductility, and may be reduced to powder by trituration.

## OBSERVATIONS.

It occurs in distinct lamellar concretions, disseminated in calcareous spar, at Sahlberg, near Sahla in Sweden; at Andreasberg in the Hartz; in argentiferous veins in gneiss, at Allemont in Dauphiné; at Przibram in Bohemia; in Mexico; and other places. It is frequently associated with the following species, from which, however, it may with facility be distinguished by its comportment before the blowpipe. The *antimony-ochre*, or earthy oxide of antimony, which occasionally accompanies this species, seems to be the product of its decomposition.

Antimony, from its property of hardening the softer metals, is employed as an alloy—particularly with lead and tin. The former constitutes type metal, and contains about one sixteenth of antimony; the latter alloy is employed for making the plates on which music is engraved. It is also used in the composition of metallic mirrors, and in several pharmaceutical preparations.

## ANTIMONIAL SILVER.

Prismatic Antimony, *M.* Octahedral Antimony, *J.* Antimonial Silver, *P.* Spiesglas-Silber, *W.* Silber Spiessglanz, *Haus.* Antimon Silber, *L.* Argent Antimonial, *H.*

Sp. Gr. 8·9—10·0.  $H. = 3\cdot5$ .

Prismatic. Indistinctly crystallized. Generally massive. *Colour* silver-white, inclining to tin-white. *Lustre* metallic. *Streak* unchanged. *Cleavage* in two directions. *Fracture* uneven. Surface in general smooth. According to Klaproth, it contains from sixteen to twenty-four per cent. of antimony, and from eighty-four to seventy-six of silver. Before the blowpipe it yields a grey metallic globule, which is not malleable; the antimony at same time being driven off in vapour. On continuing the heat a bead of silver is formed.

## OBSERVATIONS.

Antimonial silver occurs either very indistinctly crystallized, or massive and granular. It is found in veins at Altwolfach in Furstenberg, Wittichen in Swabia, and Andreasberg in the Hartz, accompanying native arsenic, several ores of silver, galena, and other species.

It is a rare mineral, but, when in sufficient quantity, is highly valuable as an ore of silver.



## ARSENICAL SILVER.

Arsenical Antimonial Silver, *P.* Argent Arsenical, *Levy.* Arsenik-Silber, *W.* Argent Antimonial Ferro-Arsenifère, *H.*

Sp. Gr. 9·4. H. = 4·0.

Crystalline form unknown; generally mammillated, or in curved lamellar distinct concretions, consisting of very thin crystalline coats. *Colour* that of metallic silver, but externally tarnished black; with a shining or glimmering metallic lustre. *Fracture* uneven. *Sectile.* Brittle. *Streak* shining. The Andreasberg variety contains silver 12·75, arsenic 35·00, antimony 4·00, iron 44·25—Klaproth.

Before the blowpipe it emits a strong arsenical odour, the arsenic and antimony being for the most part volatilized, and leaving a globule of impure silver surrounded by a slag.

## OBSERVATIONS.

It occurs in some of the Andreasberg mines, at Guadalcanal in Estremadura in Spain, and at Kongsberg in Norway, associated with antimonial silver, galena, and native arsenic. At first it might be mistaken for antimonial silver; but the copious arsenical fumes which it gives off when brought in contact with the blowpipe, and the facility with which it tarnishes on exposure to the air, are sufficiently characteristic.

## BISMUTH.

Octahedral Bismuth, *M. and J.* Native Bismuth, *P.* Gediegen Wismuth, *W.* Bismuth Natif, *H.*

Sp. Gr. 9·6—9·8. H. = 2·0—2·5.

Tessular. FIG. 129. Same as Helvine; being the tetrahedron with its angles truncated. Composition, when massive, small granular; sometimes reticulated and arborescent. *Colour* silver-white, much inclining to red, and subject to tarnish. *Lustre* metallic. *Streak* unchanged. *Sectile.* Brittle when cold; but, on being heated, may be hammered into plates. *Cleavage* perfect, and easily obtained, parallel to the faces of the octahedron. It is the pure metal, sometimes mixed with a small quantity of arsenic. It fuses readily at the comparatively low temperature of 476°. Before the blowpipe it is volatilized, and leaves a yellow coating upon the charcoal. It is so-

luble in nitric acid, but the solution yields a white precipitate if farther diluted. After fusion it produces, on slow cooling, a remarkable crystallization.

## OBSERVATIONS.

Bismuth accompanies various ores of silver, cobalt, lead, and zinc, in veins which traverse gneiss and clay-slate. Its principal localities are the silver and cobalt mines of Saxony and Bohemia, Schneeberg, Annaberg, Altenberg, Joachimsthal, Johanngeorgenstadt, &c. It is found likewise at Bieber in the principality of Hanau, at Löling in Carinthia, at Modum in Norway, at Fahlun in Sweden, &c. At Schneeberg it forms arborescent delineations disseminated in brown jasper, which have a remarkable appearance when cut into slabs and polished. It occurs with ores of cobalt at Wheal Sparnon near Redruth, at Carrock Fell in Cumberland, and formerly was found near Alloa in Stirlingshire. It crystallizes after fusion with greater facility, and more regularly, than any other metal. Its great fusibility renders it a useful compound in the formation of several metallic alloys, as in the fabrication of printers' types, pewter, and solder. Eight parts of bismuth, five of lead, and three of tin, constitute what is called, from its discoverer, Newton's metal, which melts at the heat of boiling water, and may be fused over a candle in a piece of stiff paper, without burning the paper. When calcined with the imperfect metals, its glass dissolves them, and produces the same effect as lead in cupellation.

## NATIVE LEAD.

Hexahedral Lead, *Haid.* Gediegen Blei, *L.* Plomb Natif.

Sp. Gr. 11·0—12·0. H. = 1·5.

Tessular. Massive. Colour lead-grey. Opake. Lustre metallic. Ductile. Cleavage none. It melts easily before the blowpipe, and covers the charcoal with a yellow oxide.

## OBSERVATIONS.

This is still a problematical mineral. The localities, quoted by Haidinger, are all volcanic except that of Alstone in Cumberland. The former, therefore, are questionable; and the specimens from the latter, from the circumstances under which they occurred, are somewhat doubtful. On visiting the district in 1824, with my father and Mr Haidinger, we were informed of the fact by two miners, who offered to conduct us to the spot where this rare mineral occurs. Loose incoherent masses of galena were shown to us, some of them as large as walnuts, mixed up with decomposed calcareous matter, and accompanied by crystals of blende and quartz. Many of these masses have a slaggy appearance, and contain minute globules imbedded in the galena, which were pointed out as



native lead ; while others are pure galena, distinctly cleavable, and coated with a white mealy sulphate of lead, produced by decomposition. The fact, therefore, would appear unquestionable, were it not for the neglect with which such an interesting discovery has been treated ; for, although the specimens alluded to were within reach of the surface, native lead has not yet found its way into the hands of the dealers.

### AMALGAM.

Dodecahedral Mercury, *M.* Native Amalgam, *P.* Natürlich Amalgam, *W.* Amalgam, *Haus.* and *L.* Mercure Argental, *H.*

Sp. Gr. 10·5—14·0. H. = 1·0—3·5.

Tessular. Dodecahedron. *Colour* silver-white. *Lustre* metallic. *Streak* unchanged. Traces of cleavage parallel to the faces of the dodecahedron. *Fracture* conchoidal. *Surface* smooth and shining. Brittle. Consists of

Silver 36·0 27·5

Mercury 64·0 Klaproth. 72·5 Cordier.

Before the blowpipe the mercury is volatilized, and a globule of pure silver remains. When rubbed on a piece of copper, it communicates to it a silvery lustre. Is soluble in nitric acid.

#### OBSERVATIONS.

Amalgam occasionally forms large and very perfect crystals, with numerous modifications, at Moschellandsberg in Deuxponts; also at Rosenau in Hungary. It is associated with mercury and cinnabar, in ferruginous and argillaceous veins, and is described as occurring at those points where veins of silver and mercury traverse one another.

### MERCURY.

Fluid Mercury, *M.* Fluid Native Mercury, *J.* Native Quicksilver, *P.* Gediegen Quecksilber, *W.* Mercure Natif, *H.*

Sp. Gr. 12·0—15·0. Liquid.

*Colour* tin-white. *Lustre* metallic. It is the pure metal. It is easily soluble in nitric acid, and is entirely volatilized on exposure to the blowpipe. At a temperature of — 40°, it becomes solid.

#### OBSERVATIONS.

Native mercury is of comparatively rare occurrence ; the greater part of that useful substance with which we are acquainted being obtained from cinnabar. Its most important and best-known localities are those of Idria in Carniola, and Almaden in Spain, where its production for

many centuries has been the source of very considerable revenue. At Idria it occurs in small fluid globules, scattered through a kind of slate-clay, which forms the upper portion of the mines: and from this source is obtained by means of washing. In smaller quantities, it is found at Wolfstein and Mörsfeld in the Palatinate, in Carinthia, Hungary, Peru, and other countries.

Mercury is used in various chemical and pharmaceutical preparations: in the amalgamation of gold and silver ores, for which purpose vast quantities are annually exported from Europe to the South American continent; in the formation of artificial cinnabar, and fulminating powder for percussion guns; in silvering mirrors; making thermometers and barometers, and for many other purposes.

### SILVER.

Hexahedral Silver, *M.* and *J.* Native Silver, *P.* Gediegen Silber, *W.* Argent Natif, *H.*

Sp. Gr. 10·0—11·0. H. = 2·5—3·0.

Tessular. Octahedron. *Colour* silver-white, more or less subject to tarnish. *Lustre* metallic. *Streak* shining. Ductile, but less so than gold or platina. *Cleavage* none. It is pure silver, occasionally alloyed with minute portions of antimony, arsenic, or iron, which renders it less malleable than the fused metal. It is soluble in cold nitric acid, but in sulphuric requires the aid of heat. It crystallizes from fusion, and possesses the same remarkable property as phosphate of lead, of assuming when melted before the blowpipe a crystalline form, in which octahedral, hexahedral, and dodecahedral faces may be distinctly traced.

### OBSERVATIONS.

Virgin silver generally occurs in arborescent and filiform shapes, in veins of calcareous spar or quartz, traversing gneiss, slate, and other primitive rocks. These are formed of a congeries of octahedral crystals, either closely united to one another, or disposed perpendicularly in straight rows, a structure which is very perceptible in most of the Norwegian and Mexican varieties. When large and well defined, the individuals occasionally exceed half an inch in diameter; while, on the other hand, they frequently are so minute as to be indiscernible, producing dendritic and capillary shapes, whose surface is longitudinally streaked. Magnificent specimens of native silver used to be obtained in the mines of Kongsberg in Norway; which, however, are now for the most part under water. The royal collection at Copenhagen contains a most splendid suite of specimens from this locality, among others a mass of almost pure silver, weighing above five cwt. Freyberg, Schneeberg, and Johannegeorgenstadt are its principal Saxon localities; Przibram, Joa-



chimsthal, and Ratiborzitz, its chief Bohemian ones. Silver is met with also in smaller quantities, with other ores, at Andreasberg in the Hartz, in Swabia, Hungary, at Allemont in Dauphiné, and in some of the Cornish mines. About the middle of last century, not less than L.40,000 or L.50,000 worth of silver was obtained from a mine on the estate of Alva in Stirlingshire; but it has long since been abandoned. The most celebrated localities of this metal are, however, those of the new world, Mexico and Peru, where in the former it is obtained from various ores; in the latter it is almost entirely native silver. During the first eighteen years of the present century, upwards of 8,180,000 merks of silver were raised in the mines of Guanaxuato alone. It is calculated that about eight millions sterling is the value of the silver annually produced on the earth's surface, of which about two-thirds are obtained from the mines of Mexico.

When dispersed throughout its matrix in fine particles, native silver is most easily obtained by the process of amalgamation. This is done at Freyberg in Saxony, at Joachimsthal in Bohemia, and in America. At Freyberg, the ore, which contains about four ounces of silver per cwt., together with some thirty or forty per cent. of iron pyrites, is mixed with a tenth of common salt, and roasted by passing the flame of a coal fire over it for five hours; this drives off part of the sulphur from the pyrites, and, by the decomposition of the salt, forms at once sulphate of soda and chloride of silver; about half as much mercury, some pieces of metallic iron, and a little water are then added, and, in order to produce complete amalgamation, the whole is turned round in barrels for twenty-four hours; during this operation, the mercury and silver unite in the proportion of six to one, and the chlorine and iron form muriate of iron; the amalgam, formed by the union of the silver and mercury, is reduced to its simple state by distilling the mercury under an iron bell: this is made red hot by surrounding it with fuel, and its lower extremity being placed in water, none even of the fumes can escape. Of course it is only such ores as contain little or no lead, that admit of this process; but not less than 29,000 merks of pure silver are annually obtained at Freyberg by amalgamation. The employment of silver in coinage, in the manufacture of plate, and other articles of luxury, is well known. It is mixed with copper in the proportion of  $12\frac{1}{2}$  to 1, to form the standard silver of British coinage, the silver in consequence becoming harder and more sonorous, at the same time that it remains sufficiently ductile. The malleability and ductility of silver, when pure, are such as to admit of its being drawn into wires, and beat out into leaf, like gold. It is, however, much less malleable, the continuity of its parts beginning to break when hammered into leaves of about the hundred and sixty thousandth part of an inch, which is more than one-third thicker than gold-leaf. In this state it does not transmit light, as gold does. Silver is speedily effected by sulphureous vapours,—a purple or black coating being formed when it is exposed to such exhalations: the mere atmosphere, however, tarnishes it very slightly. Ammonia forms with its oxide, the most explosive of solids—fulminating silver.

## GOLD.

Hexahedral Gold, *M.* and *J.* Native Gold, *P.* Gediegen Gold, *W.* Electrum, *Haus.*  
Or Natif, *H.*

Sp. Gr. 12·0—20·0. H. = 2·5—3·0.

**Tessular.** *Colour* various shades of gold-yellow. *Lustre* metallic. *Streak* shining. *Ductile.* *Cleavage* none. The brass-yellow variety yielded to Lampadius, gold 96·6, silver 2·0, iron 1·1. It fuses pretty easily, but is dissolved only in chlorine or nitro-muriatic acid.

## OBSERVATIONS.

Gold is not an uncommon metal; that is to say, there is none, except iron, more universally disseminated, although often in such minute quantities, that its presence can only be ascertained after pounding and washing. It occurs both in veins and beds, in nodules, plates, and small crystals, coating the cavities, or interspersed in quartz; but more frequently in the sand of rivers, in valleys and plains, into which it has been conveyed from the decomposition of auriferous rocks. This is particularly the case in Brazil, Mexico, and Peru, where it is sometimes met with in masses of several pounds weight. In Siberia too, it occurs in a similar alluvium or sand, in the country eastward of the Ural Mountains, where masses of eight, ten, or sixteen pounds have occasionally been discovered. In Transylvania a considerable quantity of gold is obtained from stream works, as at Ohlapian near Hermannstadt. In the Wicklow Mountains of Ireland, and at Leadhills in Scotland, it occurs in alluvial soil; and in many districts of Germany it presents itself under similar circumstances. My father's collection contains a specimen of a light-yellow colour, weighing nearly eight sovereigns, from the Breadalbane estate, near Glen Coich in Perthshire. In some places, as at Vorospatak, near Abrudbanya in Transylvania, the rock appears impregnated with small portions of gold, which occur crystallized, and in slender plates, disseminated through the mass. The mines of Hungary and Transylvania, Cremnitz, Schemnitz, Posing, Botza, Magurka, Nagyag, Offenbanya, and Boitza, are all worked for this metal, occasionally affording the most splendid specimens; and in Saltzburg, and thence along the chain of the Alps as far as La Gardette near Allemont in Dauphiné, there are numerous other establishments of a similar description. The Russian and Siberian mines have also latterly afforded considerable quantities of gold; and to the United States it promises to be a mineral product of some importance.

Pure gold possesses a characteristic deep yellow colour, though most gold coins present a paler hue, from a per-centage of silver or copper which is added to make them harder, as in the British sovereign, which is alloyed by one twelfth part of copper. Even in nature it rarely occurs



quite pure, but generally contains a little silver; and when this is in large quantity, its colour is lighter. There are many metallic minerals, also, which contain small portions of gold, particularly native tellurium, and the auriferous crystals of iron-pyrites from Brazil and Siberia. Its most common crystalline form is the icositetrahedron, fig. 15; sometimes, however, it presents the regular octahedron and cube, and occasionally exhibits macles of the most compound description.

*Electrum*, or *Argentiferous Gold*, is distinguished by its silver-white colour. It afforded to Klaproth 64 per cent. of gold and 36 of silver; to Boussingault, 74 gold and 26 silver; to Rose, 76.41 gold and 23.12 silver; and to Fordyce only 28 per cent. of gold. Its specific gravity consequently varies from 14.0 to 17.0. It occurs at Schlangenberg in Siberia, Kongsberg in Norway, and other mining districts. A greyish-yellow variety occurs in the platina mines of Siberia, and is supposed to derive its peculiar tint from a mixture of that metal.

The uses of native gold are pretty well known. It is the most ductile and flexible of all metals, and is at same time very soft; indeed the limits of its ductility and malleability are unknown. By the weight and measure of the best wrought gold leaf, says Dr Ure, it is found that one grain is made to cover  $56\frac{3}{4}$  square inches; and from the specific gravity of the metal, together with this admeasurement, it follows that the leaf itself is the two hundred and eighty thousandth part of an inch thick. The wire, too, which is used by lace-makers, is drawn from an ingot of silver previously gilded. In this way, from the known diameter of the wire, or breadth when flattened, and its length, together with the quantity of gold used, it is found by computation that the covering of gold is only a twelfth part of the thickness of gold leaf, though it is still so perfect as to exhibit no cracks when examined with a microscope.

The electric shock converts gold into a purple oxide, as may be observed by transmitting it through gold leaf confined between two plates of glass. Its colour when melted is a bluish-green, the same as is exhibited by light transmitted through gold leaf. When combined with ammonia its oxide forms fulminating gold, which possesses the property of detonating with considerable noise, when gently heated. Most metals unite with gold by fusion; silver renders it paler in colour, according to the proportion; with mercury it forms an amalgam; lead impairs its ductility, one quarter of a grain to an ounce of gold rendering it completely brittle; copper makes it less ductile, harder, more fusible, and of a deeper colour; tin renders it brittle in proportion to its quantity; with iron it forms a grey mixture, which obeys the magnet; bismuth, nickel, manganese, arsenic, zinc, and antimony, render it white and brittle.

From 1801 to 1818, twenty-four thousand five hundred marks of gold were produced from the mines of Guanaxuato in Mexico; and it is calculated, that on an average rather more than three millions sterling of gold is annually supplied by South America.

## IRIDIUM.

Rhombohedral Iridium, *Haid.* Iridium, *J.* Alloy of Iridium and Osmium, *P.*

Sp. Gr. 19·0—20·0. H. above 4·5.

Rhombohedral. Rarely in six-sided prisms of a light steel-grey colour, generally in grains. Opake. *Lustre* metallic. *Cleavage* easily obtained, parallel to the summit of the prism. Ductile and malleable. Fused with nitre it becomes black, but regains both its lustre and colour when heated with charcoal. It contains, osmium 24·5, iridium 72·9, iron 2·6—Thomson. It is not soluble in nitro-muriatic acid.

## OBSERVATIONS.

This was first discovered by Dr Wollaston, who ascertained it to be an alloy of iridium and osmium. It occurs along with platina, in the province of Choco in South America; but is not only paler in colour, but harder and heavier, than that metal. It is also found in the Ural Mountains.

## PALLADIUM.

Octahedral Palladium, *Haid.*

Sp. Gr. 11·5—12·5. H. above 4·5.

Tessular. Form unknown; in grains. *Colour* steel-grey. *Cleavage* none. *Lustre* metallic. Ductile, and very malleable. Flexible when in thin slips, but not particularly elastic. It yields a red solution with nitric acid; and is soluble in muriatic, but not in sulphuric acid, unless heated. It is infusible when alone, but on the addition of sulphur it melts with ease; and when the heat is continued it is reduced.

## OBSERVATIONS.

Palladium was discovered by Dr Wollaston, who proposed the following method of reducing it to a malleable state. The residuum obtained from burning the prussiate of palladium is combined with sulphur; and each cake of the sulphuret, after being fused, is finally purified, by cupellation in an open crucible, with borax and nitre. The sulphuret is then roasted at a low red heat on a flat brick, and pressed, when reduced to a pasty consistence, into a flat cake, which must again be roasted patiently, until it becomes spongy on the surface. Its sulphur being thus driven off, the ingot is allowed to cool, and is thereafter tapped with a light hammer, to flatten the spongy excrescences on its surface. These alternate roastings and hammerings require great patience before the cake will admit of



being passed through the flatting mill, and so brought to perfection by being laminated to any required degree of thinness. (Ure's Dictionary).

It occurs along with native platina in Brazil, and in external characters bears much resemblance to that substance. Its texture, however, appears more fibrous and diverging. Zinken has also observed it in small white shining masses, interspersed with seleniuret of lead, in the Hartz. (Jahresbericht, 1832, p. 202).

## PLATINA.

Native Platina, *M. J.* and *P.* Hexahedral Platina, *Haid.* Gediegen Platin, *W.* and *L.* Polyxen, *Haus.* Platine Natif Ferrière, *H.*

Sp. Gr. 16·0—20·0. H. = 4·0—4·5.

Tessular. In irregular forms and grains, of a perfect steel-grey colour. Lustre metallic. Streak unchanged and shining. Cleavage none. Ductile. Consists of

	Small grains, <i>Ural.</i>		Large grains, <i>Columbia.</i>
Platina	80·87	78·94	84·30
Rhodium	11·07	0·86	3·46
Palladium	1·64	0·28	1·06
Iridium	0·00	4·97	1·46
Osmium	0·00	0·00	1·03
Osmiuret of iridium	0·00	1·96	0·00
Copper	2·05	0·70	0·74
Iron	2·30	11·04	5·31
Sulphur	0·79	Ossman. 0·00	0·00 Berzel.

It is soluble only in nitro-muriatic acid. It requires a much higher degree of heat than can be produced by the common blowpipe, to cause fusion; but at the oxy-hydrogen flame it melts like lead. It slightly affects the magnet, in proportion to the amount of iron which it contains.

## OBSERVATIONS.

Platina occurs in pebbles and grains, generally of small size, associated with iridium, rhodium, osmium, palladium, gold, copper, and chrome, in the alluvial deposits of Brazil, Choco, and Barbacoa in South America. It is never met with pure, being in fact alloyed with about twenty per cent. of other substances, particularly rhodium, iridium, osmium, and palladium,—four metals which were unknown till discovered in platina. It has of late years been met with so abundantly at Joetsk in the Perm government of Siberia, that the Russians have converted it into a medium of exchange, by coining it into ducats of ten roubles, value forty-five shillings. These are not a legal tender, but pass conventionally, and are principally current in the southern provinces of the

empire. For the Russian mode of rendering it malleable, see *Ann. of Phil.* for May 1832.

The Royal Museum of Madrid contains a water-worn mass from the gold mines of Condoto in South America, which weighs one pound nine ounces, and measures upwards of two inches in either direction. Humboldt deposited at Berlin a native specimen of Peruvian platina, weighing 1083 grains. Since 1822, the Madrid Museum has been enriched with another American mass of 11,641 grains; and a still more remarkable specimen was within these few years discovered in the Urals, which weighed ten and a half Russian pounds, above 81,000 grains; it is preserved at St Petersburg. (*Edin. New Phil. Jour.* iv. 185.) The rough and abraded surfaces of these masses occasionally exhibit indistinct traces of crystallization.

The refractory properties of this metal, its freedom from rust or tarnish, and its not being acted upon by most chemical re-agents, render it extremely valuable in the construction of philosophical and chemical apparatus. Its extreme ductility, also, admits of its being extended into wire not exceeding the two thousandth part of an inch in diameter; so extremely fine, as almost to be beyond the reach of the naked eye. It is used for covering other metals, for painting on porcelain, &c. A detailed account of Dr Wollaston's valuable method of rendering platina completely malleable and ductile, is contained in the *Philosophical Transactions* for 1829.

#### NATIVE IRON.

Octahedral Iron, *M.* and *J.* Native Iron, *P.* Gediegen Eisen, *W.* and *L.* Meteoreisen, *Haus.* Fer Natif, *H.*

Sp. Gr. 7.4—7.8. H. = 4.5.

*Tessular.* Colour pale steel-grey. Lustre metallic. Streak unchanged, shining. Acts powerfully on the magnet. Cleavage none. Ductile. Klaproth found in several of the principal masses,

	Agram.	Siberia.	Mexico.	Atacama.
Iron	96.5	98.5	96.75	93.40
Nickel	3.5	1.5	3.25	6.62
Cobalt	0.0	0.0	0.00	0.53 Turner.

It is infusible before the blowpipe; but is soluble in acids, and resembles pure iron in most of its properties.

#### OBSERVATIONS.

Native iron is found in detached masses of various sizes on the surface of the earth. Among the most remarkable of these may be noticed, that discovered by Pallas in Siberia, with its imbedded crystals of chrysolite, which was originally about 1600 pounds weight; that of the province of Bahia in Brazil, whose contents are at least twenty-eight cubic feet and



weight 14,000 pounds (vide *Phil. Trans.* 1816); that discovered by Don Rubin de Celis in the district of Chaco-Gualamba, in South America,—one of the largest known, and estimated at 30,000 pounds; that of Elbogen in Bohemia, which weighed about 120 pounds; and that of Agram in Croatia, which, according to credible witnesses, was seen falling from the sky in two pieces. Many masses are scattered over the continent of North America (*Brewster's Journal*, II. 138), particularly in the higher latitudes; and Captain Ross mentions two in Greenland. Several masses have also been found in Africa, as on the Senegal River, and near the Cape of Good Hope.

Except the Siberian variety mentioned by Pallas, a mass found in Poland in 1809, which was said to have resembled it, and that lately noticed in the desert of Atacama in Peru (*Trans. Royal Soc. Edin.* vol. XI.) which not only has the same vesicular structure, but contains the same straw-yellow coloured olivine as the Siberian, other native irons have uniformly presented a solid structure, or, at least, were composed of metallic iron. It has been worked into knives, swords, and other instruments, and forms the substance of the rough-shaped knives of some of the American Esquimaux tribes. *Silliman's Journal* for March 1827, contains an account of a vein of native iron traversing mica-slate, in Canaan, North America. It is described as presenting the usual characters of native iron; but being mechanically associated with plumbago, it falls short of it in malleability, toughness, and flexibility: its specific gravity is also less. The imperial cabinet at Vienna contains an extensive and interesting collection of meteoric irons; among others, a portion of the Elbogen mass, and the larger of the two that fell at Agram.

Nickel or chrome is found to be a constant and characteristic ingredient of meteoric iron, these substances never being found in other ores of that metal.

In most collections the aerolites are classed with native iron, principally from their origin being considered identical. Their chemical composition, however, varies considerably; and they may with more propriety be looked upon as mixed minerals or rocks, than as distinct species. A particular description of them here is unnecessary.

### NATIVE COPPER.

Octahedral Copper, *M.* and *J.* Native Copper, *P.* *Gediegen Kupfer of the Germans.*  
Cuiivre Natif, *H.*

Sp. Gr. 8.4—8.9. H. = 2.5—3.0.

Tessular. Octahedron. Colour copper-red. Lustre metallic. Streak unchanged and shining. Cleavage none. Ductile. It is the pure metal as produced by nature. Before the blowpipe it fuses easily, but on cooling becomes covered with a black

oxide. It dissolves readily in nitric acid, and crystallizes from fusion.

#### OBSERVATIONS.

Copper occurs in some countries perfectly pure, unconnected with any other substance; in Cornwall, Brazil, and Siberia, in veins; also to the southward of Lake Superior, in large blocks, which frequently exceed a ton in weight. Sometimes it is disseminated through the matrix, at others it occupies clefts and fissures in aggregated branching groups, and, though less frequently, occurs massive and botryoidal. The most splendid crystalline varieties are those of Siberia, and the island of Nalsole in Faroe, where it accompanies compact fibrous mesotype in amygdaloidal trap. It does not traverse this in veins, but is disseminated in minute particles, and sometimes presents crystallizations equal in beauty to any from the mines of Cornwall, although imbedded in the solid substance of the rock, through which it branches with the utmost elegance. Some very singular crystallizations, produced by the elongation of the simple individual, occur at Moldava in the Bannat, at Chessy in France, Herengrund in Hungary, and elsewhere. Cornwall, however, is certainly the greatest repository of native copper, and many of the mines near Redruth; the Consolidated mines, Wheal Buller, and some others, afford it in considerable quantities. Its crystals are rarely regular, their faces being disproportionately enlarged, and they are generally grouped in branches, formed by the union of these crystals in rows, in a manner analogous to the crystalline structure of native silver.

The application of copper in the arts is well known, being employed not only pure, but in combination with other metals. Silver, by a small addition of copper, becomes harder; and for certain purposes is on that account used as an alloy. Copper, with zinc, forms brass, which, though less ductile, is more easily fused, takes a higher polish, and is less affected by the weather, than copper. Combined with tin it becomes tough and sonorous; and in this state is used in the construction of cannon and the formation of bells. The copper sheathing of ships, to obstruct the devastations of the teredo, pholas, and other molluscæ, is well known; as is also its employment in coining and engraving, and in the fabrication of various utensils. From its property of not emitting sparks, it is used in the stamping machinery of powder mills; and by the ancients it was extensively employed in constructing their weapons.

A small portion only, of the copper employed for these purposes, is derived from this species, metallic copper being principally obtained from copper pyrites and other ores of that metal.



## ORDER PYRITES.

### COPPER NICKEL.

Prismatic Nickel Pyrites, *M.* and *J.* Copper Nickel, Arsenical Nickel, *P.* Kupfer-nickel, *W.* Arsenik-nickel, *L.* Nickel Arsenical, *H.*

Sp. Gr. 7.5—7.7. H. = 5.0—5.5.

Prismatic. Massive. Colour copper-red, acquiring a grey tarnish on exposure. Lustre metallic. Streak pale brownish-black. Cleavage unknown. Fracture small conchoidal. Brittle.

	Riechelsdorf.	Allemont.	
Contains Nickel	44.21	48.90	39.94
Arsenic	54.73	46.42	48.80

Antimony 0.00 Strom. 0.00 Pfaff. 8.00 Berthier.

with minute proportions of iron, lead, sulphur, and cobalt.

Its chemical formula corresponds to 44.01 nickel, and 55.99 arsenic. Before the blowpipe it fuses, and emits an arsenical odour, leaving a white brittle metallic bead. In nitric acid it soon assumes a green coating, and in nitro-muriatic acid is dissolved.

#### OBSERVATIONS.

Copper nickel occurs associated with cobalt, silver, and copper, particularly in the Saxon mines of Annaberg, Schneeberg, Marienberg, Gersdorf, &c. It is likewise found at Saalfeld in Thuringia, at Riechelsdorf in Hessa, at Schladming in Styria, at Allemont in Dauphiné, and, though not frequently, in Cornwall. Specimens of this species have occasionally been mistaken for native copper; but its brittle nature, and the green deposit it forms in nitric acid, serve sufficiently to distinguish it.

A considerable portion of nickel is used in the manufacture of what is now pretty generally known in this country under the denomination of “German silver;” that substance being composed of copper 53.9, zinc 29.13, nickel 17.48. In small quantities it also enters into the composition of various other metallic alloys.

The apple-green friable substance called *arsenate of nickel*, or *nickel ochre*, which frequently accompanies copper-nickel, is produced by its decomposition, and contains, according to Stromeyer, 36.97 arsenic acid,

37·35 oxide of nickel, and 24·32 water, with a little iron, and sulphuric acid. It dissolves readily in acids; when calcined, assumes a yellow colour; and, before the blowpipe, exhales a strong odour of arsenic, fusing in the reducing flame into a globule of arseniferous nickel. Bournon in his catalogue mentions some minute crystals of this substance, presenting the form of six-sided prisms.

### ARSENICAL PYRITES.

Axotomous Arsenical Pyrites, *M.* Prismatic Arsenical Pyrites, Axotomous Arsenic Pyrites, *J.*

Sp. Gr. 7·1—7·4. H. = 5·0—5·5.

Prismatic. FIG. 66. Inclination of *o* to *o* over the apex =  $51^{\circ} 20'$ , of *d* to *d* =  $122^{\circ} 26'$ . Colour between silver-white and steel-grey. Lustre metallic. Streak greyish-black. Cleavage perfect perpendicular to the axis. Fracture uneven. Brittle. It contains arsenic and iron.

#### OBSERVATIONS.

Arsenical pyrites is a rare mineral, seldom occurring crystallized, and, even when massive, only in small quantities. It is found associated with copper-nickel at Schladming in Styria; with serpentine at Reichenstein in Silesia; and in a bed of sparry iron, along with bismuth and scorodite, at Löling, near Hüttenberg in Carinthia.

### MISPICKEL.

Prismatic Arsenical Pyrites, *M.* Prismatic Arsenic Pyrites, Arsenical Pyrites, *J.* Di-  
Prismatic Arsenical Iron, Mispickel, *P.* Arsenik-kies of the Germans. Fer Arsenical, *H.*

Sp. Gr. 5·7—6·2. H. = 5·5—6·0.

Prismatic. FIG. 148. Inclination of *M* to *M* =  $111^{\circ} 53'$ , of *r* to *r* =  $145^{\circ} 26'$ . Colour silver-white, inclining to steel-grey or yellow. Lustre metallic. Streak dark greyish-black. Cleavage parallel to *M*. Fracture uneven. Brittle.

Freyberg.

Contains Iron	36·04	34·94
Arsenic	42·88	43·42
Sulphur	21·08 Stromeyer.	20·13 Chevreul.

Its chemical formula corresponds to 33·5 iron, 46·5 arsenic, and 20·0 sulphur. Before the blowpipe, upon charcoal, it gives off copious arsenical fumes, and forms a globule of nearly pure sulphuret of iron, which acts upon the needle like magnetic pyrites. It is soluble in nitric acid, with the exception of a whitish residue; and gives fire with steel, emitting at same time a garlic odour.



## OBSERVATIONS.

Mispickel occurs principally in primitive mountains, accompanying ores of silver, lead, and tin; also associated with pyrites, quartz, and blende. It is plentiful in some of the mining districts of Saxony, forming veins at Freyberg and Munzig, and beds at Breitenbrunn and Raschau. It occurs also at Andreasberg in the Hartz, at Joachimsthal in Bohemia, at Tunaberg in Sweden, and at Wheal Mawdlin, Unanimity, and other mines, in Cornwall.

Mispickel is worked as an ore of Arsenic, the white oxide of commerce being principally obtained from it. Its alliaceous odour when struck, and its comportment before the blowpipe, distinguish this species from any others with which in external appearance it might be confounded.

## GREY COBALT.

Octahedral Cobalt-Pyrites, *M.* Octahedral Cobalt Pyrites, or Tin-White Cobalt, *J.* Tin-White Cobalt, *P.* Weisser-Speiskobold, *W.* Speiskobalt, *Haus.* and *L.* Cobalt Arsenical, *H.*

Sp. Gr. 6·4—6·6. H. = 5·5.

Tessular. FIG. 149. *Colour* tin-white, inclining, when massive, to steel-grey. *Lustre* metallic. *Streak* greyish-black. *Cleavage* parallel to the faces both of the octahedron and cube. *Fracture* granular and uneven. Brittle. Faces of the crystals frequently cracked. The Riechelsdorf variety contains cobalt 20·31, arsenic 74·21, iron 3·42, copper 0·15, sulphur 0·88—Stromeyer. Its chemical formula corresponds to 22·30 cobalt, and 77·70 arsenic. When heated at a candle, it emits copious fumes and a strong odour of arsenic, and melts into a white brittle metallic globule. It imparts a blue colour to borax and other fluxes, and affords a pink solution with nitric acid.

## OBSERVATIONS.

Grey cobalt is met with principally in veins, accompanying ores of silver or copper, as at Freyberg, Annaberg, and particularly at Schneeberg, in Saxony; at Joachimsthal in Bohemia; and at Wheal Sparnon in Cornwall. At Riechelsdorf in Hessa its veins are included in cupriferous shale; and the reticulated variety from Joachimsthal is frequently imbedded in calcareous spar.

Wherever it occurs, copper nickel is its constant attendant, to the miner's no small annoyance; for even a minute portion is sufficient to destroy the fine blue colour obtained from cobalt. Native bismuth is another frequent accompaniment of this and the following species, though

it may easily be distinguished from either, by its perfect cleavage, inferior hardness, and reddish tinge.

Grey cobalt, simply roasted to drive off the arsenic, and then finely pounded, affords a blue colour for painting porcelain, stoneware, and other pottery. Its colouring power on vitreous mixtures is greater perhaps than that of any other metal; one grain of the oxide giving a full blue to 240 grains of glass. With silex and potash it produces smalt.

### WHITE COBALT.

Hexahedral Cobalt Pyrites, *M.* Hexahedral Cobalt Pyrites, or Silver-White Cobalt, *J.* Bright White Cobalt, *P.* Glanz Kobold, *W.* Kobalt Glanz, *Haus.* and *L.* Cobalt Gris, *H.*

Sp. Gr. 6.1—6.35. H. = 5.5.

Tessular. FIG. 150. Combination of the cube, and pentagonal dodecahedron. Inclination of  $e$  to  $e = 126^\circ 52'$ , of  $e$  to  $e' = 113^\circ 35'$ . Faces of the cube streaked—those of  $e$  smooth and shining. Colour silver-white, inclining to red. Lustre metallic. Streak greyish-black. Brittle. Cleavage perfect in the plane of the cube. Fracture uneven and lamellar. Consists of

	Tunaberg.		Modum.
Cobalt	44.0	36.66	33.10
Arsenic	55.5	49.00	43.46
Iron	0.0	5.66	3.23

Sulphur 0.5 Klaproth. 6.50 Tassaert. 20.08 Stromeyer.

Corresponding to the chemical formula for 35.27 cobalt, 45.27 arsenic, and 19.46 sulphur. It gives out copious arsenical fumes when exposed to the action of the blowpipe, and melts after being roasted, into a dull black metallic globule, which attracts the magnet. It imparts a blue colour to borax, and effervesces in heated nitric acid like the preceding species.

### OBSERVATIONS.

This and the last species are the ores of cobalt, from which the smalt of commerce is principally obtained. At Tunaberg and Hokensbo in Sweden, it is met with in large, resplendent, distinctly-pronounced crystals, which are generally combinations of the cube and the pentagonal-faced dodecahedron; also at Modum in Norway, where it is mined to considerable extent. Querbach in Silesia, and the vicinity of St Just in Cornwall, are other localities; though perhaps the most productive mines of this ore are those of Wehna in Sweden, where it occurs in mica slate. These mines were opened in the year 1809.

This may be distinguished from the last species by its lower specific gravity, and reddish hue; also by its lamellar structure, its more distinct



cleavage, and by its requiring considerably greater heat to drive off the arsenic. It is a valuable ore to the porcelain painter.

### COBALT-KIES.

Isometric Cobalt Pyrites, *M.* Cobalt-Kies, *J.* Sulphuret of Cobalt, *P.* Kobaltkies, *L.*

Sp. Gr. 6·3—6·4. H. = 5·5.

Tessular. FIG. 151. Massive; composition granular. *Colour* pale steel-grey, inclining to copper-red when tarnished. *Lustre* metallic. *Cleavage* parallel to the faces of the cube, imperfect. *Fracture* uneven, or imperfect conchoidal. The Swedish variety contains cobalt 43·20, copper 14·40, iron 3·53, sulphur 38·50—Hisinger.

It emits a sulphureous odour before the blowpipe, and after being roasted communicates a blue colour to glass of borax.

#### OBSERVATIONS.

It is found at Bastnaes near Riddarhyttan, in Sweden, in beds of gneiss, associated with copper pyrites and hornblende; and at Mussen near Siegen, in Prussia, with barytes and carbonate of iron.

### NICKELIFEROUS GREY ANTIMONY.

Eutomous Cobalt Pyrites, *M.* Nickeliferous Grey Antimony, *J.* Nickelspiesglaserz of the Germans. Antimoine Sulfuré Nickelifère, *H.*

Sp. Gr. 6·4—6·5. H. = 5·0—5·5.

Tessular. Massive; composition granular. *Colour* steel-grey, inclining to silver-white. *Lustre* metallic. *Cleavage* perfect, parallel to the faces of the cube. Brittle. Consists of

Nickel	36·60	25·25
Antimony	43·80	47·75
Arsenic	0·00	11·75
Sulphur	17·71	15·25

Iron and manganese 1·89 Strom. 0·00 Klap.

It is partly volatilized before the blowpipe, during which the supporting charcoal is covered with a white coating. Ultimately it melts into a metallic globule, which communicates a blue colour to glass of borax.

#### OBSERVATIONS.

It occurs in several of the mines near Freussberg, in the principality of Nassau, along with sparry iron, galena, and copper pyrites.

## IRON PYRITES.

Hexahedral Iron Pyrites, *M.* and *J.* Iron Pyrites, *P.* Gemeiner Schwefelkies, *Zelkies*, *W.* Eisenkies, *L.* Fer Sulfuré, *H.*

Sp. Gr. 4.9—5.05. H. = 6.0—6.5.

Tessular. FIG. 13. Pentagonal dodecahedron. Inclination of *c* to *c* =  $126^{\circ} 52'$ ; of *c* to *c'* =  $113^{\circ} 35'$ ; also amorphous, mammillated, and stalactitic. Colour of a characteristic bronze-yellow; sometimes tarnished. Lustre metallic. Streak brownish-black. Brittle, but does not yield to the knife; this serves to distinguish it from copper pyrites, which yields readily to it. Cleavage parallel to the faces of the cube and octahedron more or less distinct. Fracture conchoidal, uneven. Consists of

Iron	47.85	45.74
Sulphur	52.15 Hatchett.	54.26 Berzelius.

the latter analysis precisely corresponding with the chemical formula. In the oxidating flame of the blowpipe upon charcoal it becomes red; the sulphur being driven off, and an oxide of iron, which is magnetic, remaining. It gives fire with steel, and thence derives its name from the Greek, *πυρ*, fire. Some varieties are subject to decomposition. It is partly soluble in heated nitric acid, leaving a white residue.

## OBSERVATIONS.

Iron pyrites presents itself in small cubical crystals and grains, in various slate-rocks and coal-seams; in balls and crystalline groups, imbedded in clay; or accompanying ores of lead, iron, &c. It, in fact, extends from the oldest primitive rocks, down to the most recent alluvial deposits; although, according to Brongniart, it has seldom been observed either in gypsum or anthracite. The crystals from Elba are conspicuous for their size, forming pentagonal dodecahedrons three or four inches in diameter. Cubes of gigantic dimensions have occurred in some of the Cornish mines; very perfect octahedrons of equal size are found at Persberg in Sweden; and splendid specimens have been brought from Peru; though perhaps the best defined and most brilliant individuals are those from Traversalla in Piemont. Alston Moor, Derbyshire, and the mining districts of Cornwall, afford it in great profusion and under various forms, sometimes crystallized, frequently coating fluor spar, galena, and other minerals. Fahlun in Sweden, Kongsberg in Norway, Freyberg and other places in Saxony, Hungary, Bohemia, and the Hartz, are also well known localities; and some very remarkable compound crystals have been found, in clay at Munden near Hanover,



*Streak* dark greyish-black. *Brittle*. *Cleavage* perfect parallel to P, less distinct parallel to M. Slightly magnetic; and subject to speedy tarnish. It has yielded

	Cornwall.	Utön.	Pyrenees.
Iron	63·5	59·85	56·37
Sulphur	36·5 Hatchett.	40·15 Strom.	43·63 Strom.

Before the blowpipe it affords similar results to the preceding species, and is soluble in dilute sulphuric acid.

## OBSERVATIONS.

Magnetic pyrites is a compound of iron and sulphur, but in such proportions as to constitute a triple sulphuret, while the two last species are bi-sulphurets. It rarely occurs crystallized, generally forming granular or amorphous masses in the fissures of certain primitive rocks. Crystalline plates, however, have been noticed at Kongsberg in Norway, and at Andreasberg in the Hartz; and in some of the Vienna collections there are large distinct crystals from a locality now unknown. The cleavable varieties are principally from Bodenmais in Bohemia, where they are associated with iolite; and the granular, compact, and massive, from Cornwall, Appin in Argyleshire, Saxony, Silesia, and the Hartz. It has likewise been observed among the lavas of Vesuvius; and its presence has been detected even in the mass of certain meteoric stones.

Being frequently associated with iron pyrites, it is employed with that substance in the manufacture of sulphuric acid and sulphate of iron. Its peculiar colour and inferior hardness prevent its being confounded with either of the foregoing species.

## BUNTKUPFERERZ.

Octahedral Copper Pyrites, *M.* Variegated Copper, *J.* Buntkupfererz, Purple Copper, *P.* Buntkupfererz, *W.* and *L.* Bunter Kupferkies, *Haus.* Cuivre Pyritéux Hepatique, *H.*

Sp. Gr. 4·9—5·1. H. = 3·0.

*Tessular*. FIG. 154. General form the cube with its solid angles replaced. *Colour* between copper-red and pinchbeck-brown. *Lustre* metallic. *Streak* pale greyish-black, and slightly shining. Traces of cleavage parallel to *o*, the faces of the octahedron.

	Killarney.	Norway.	Silesia.
Contains Copper	61·07	69·5	58·0
Sulphur	23·75	19·0	19·0
Iron	14·00	7·5	18·0
Silica	0·50	0·0	0·0
Oxygen	0·00 Phillips.	4·0 Klap.	5·0 Klap.

## IRON PYRITES.

Hexahedral Iron Pyrites, *M.* and *J.* Iron Pyrites, *P.* Gemeiner Schwefelkies, *Zelkies*,  
*W.* Eisenkies, *L.* Fer Sulfuré, *H.*

Sp. Gr. 4.9—5.05. H. = 6.0—6.5.

Tessular. FIG. 13. Pentagonal dodecahedron. Inclination of  $e$  to  $e = 126^\circ 52'$ ; of  $e$  to  $e' = 113^\circ 35'$ ; also amorphous, mammillated, and stalactitic. Colour of a characteristic bronze-yellow; sometimes tarnished. Lustre metallic. Streak brownish-black. Brittle, but does not yield to the knife; this serves to distinguish it from copper pyrites, which yields readily to it. Cleavage parallel to the faces of the cube and octahedron more or less distinct. Fracture conchoidal, uneven. Consists of

Iron	47.85	45.74
Sulphur	52.15 Hatchett.	54.26 Berzelius.

the latter analysis precisely corresponding with the chemical formula. In the oxidating flame of the blowpipe upon charcoal it becomes red; the sulphur being driven off, and an oxide of iron, which is magnetic, remaining. It gives fire with steel, and thence derives its name from the Greek,  $\piυρ$ , *fire*. Some varieties are subject to decomposition. It is partly soluble in heated nitric acid, leaving a white residue.

## OBSERVATIONS.

Iron pyrites presents itself in small cubical crystals and grains, in various slate-rocks and coal-seams; in balls and crystalline groups, imbedded in clay; or accompanying ores of lead, iron, &c. It, in fact, extends from the oldest primitive rocks, down to the most recent alluvial deposits; although, according to Brongniart, it has seldom been observed either in gypsum or anthracite. The crystals from Elba are conspicuous for their size, forming pentagonal dodecahedrons three or four inches in diameter. Cubes of gigantic dimensions have occurred in some of the Cornish mines; very perfect octahedrons of equal size are found at Persberg in Sweden; and splendid specimens have been brought from Peru; though perhaps the best defined and most brilliant individuals are those from Traversalla in Piemont. Alston Moor, Derbyshire, and the mining districts of Cornwall, afford it in great profusion and under various forms, sometimes crystallized, frequently coating fluor spar, galena, and other minerals. Fahlun in Sweden, Kongsberg in Norway, Freyberg and other places in Saxony, Hungary, Bohemia, and the Hartz, are also well known localities; and some very remarkable compound crystals have been found, in clay at Munden near Hanover,



*Streak* dark greyish-black. *Brittle*. *Cleavage* perfect parallel to P, less distinct parallel to M. Slightly magnetic; and subject to speedy tarnish. It has yielded

	Cornwall.	Utön.	Pyrenees.
Iron	63.5	59.85	56.37
Sulphur	36.5 Hatchett.	40.15 Strom.	43.63 Strom.

Before the blowpipe it affords similar results to the preceding species, and is soluble in dilute sulphuric acid.

## OBSERVATIONS.

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Being frequently associated with iron pyrites, it is employed with that substance in the manufacture of sulphuric acid and sulphate of iron. Its peculiar colour and inferior hardness prevent its being confounded with either of the foregoing species.

## BUNTKUPFERERZ.

Octahedral Copper Pyrites, *M.* Variegated Copper, *J.* Buntkupfererz, Purple Copper, *P.* Buntkupfererz, *W.* and *L.* Bunter Kupferkies, *Haus.* Cuivre Pyritéux Hepatique, *H.*

Sp. Gr. 4.9—5.1. H. = 3.0.

*Tessular*. FIG. 154. General form the cube with its solid angles replaced. *Colour* between copper-red and pinchbeck-brown. *Lustre* metallic. *Streak* pale greyish-black, and slightly shining. Traces of cleavage parallel to *o*, the faces of the octahedron.

	Killarney.	Norway.	Silesia.
Contains Copper	61.07	69.5	58.0
Sulphur	23.75	19.0	19.0
Iron	14.00	7.5	18.0
Silica	0.50	0.0	0.0
Oxygen	0.00 Phillips.	4.0 Klap.	5.0 Klap.

the chemical formula being expressive of 62·67 copper, 23·89 sulphur, and 13·44 iron. It blackens before the blowpipe, and becomes red on cooling; but at a sufficient temperature fuses into a globule, which acts on the magnetic needle.

## OBSERVATIONS.

Crystalline varieties of Buntkupfererz have hitherto been found exclusively in Cornwall, and that principally in the copper mines of Tincroft and Dolcoath near Redruth. It occurs massive and compact, however, with green carbonate of copper in Norway, Siberia, Hessa, Silesia, and the Bannat; also at Ross Island in Killarney, in Ireland; and in cupriferous shale in the Mansfield district. It is a valuable ore of copper. Haüy classifies it with copper pyrites, of which he considers it a decomposed variety; it differs, however, essentially, not only in composition, but in form and specific gravity.

## COPPER PYRITES.

Pyramidal Copper Pyrites, *M.* Octahedral Copper Pyrites, or Yellow Copper Pyrites, *J.*  
Yellow Copper Ore, *P.* Kupferkies, *W.* and *L.* Cuivre Pyriteux, *H.*

Sp. Gr. 4·1—4·3. H. = 3·5—4·0.

Pyramidal. FIG. 155. Colour brass-yellow, but frequently subject to tarnish. Lustre metallic. Streak greenish-black and a little shining. Cleavage sometimes perfect, parallel to *c*. Fracture conchoidal. Contains

Copper	32·0	30·00	33·12
Iron	34·0	32·20	30·00
Sulphur	33·0	35·16	36·52
Silica	0·0 Breithaupt.	0·00 Phillips.	0·39 Rose.

The most probable atomic constitution of copper pyrites, as indicated by the analysis of Mr R. Phillips (*Ann. of Phil. N. S.* III. 301), is that of two atoms proto-sulphuret of iron, and one atom of bi-sulphuret of copper, with variable quantities of arsenic and earthy matter.

Its comportment before the blowpipe resembles that of the last species, fusing into a metallic globule, which acts on the magnet; and giving with borax a copper bead. It forms a green solution in dilute nitric acid, a portion of sulphur remaining undissolved.

## OBSERVATIONS.

This is by much the most abundant and most important ore of copper; nearly one third, it is calculated, of all the copper obtained by metallur-



gic processes being extracted from it, and in Great Britain yielding more metallic copper than all the other ores of copper together. Its crystalline forms are likewise extremely remarkable. These at one time were considered octahedral; but have latterly, in consequence of their angles being ascertained to differ slightly from those of the octahedron, been referred to the pyramidal system. Frequently the alternate faces of the four-sided pyramid are so much enlarged, that a regular tetrahedron is produced; and very often it presents twin-crystals, which consist of two, three, or more individuals, aggregated in the most grotesque manner imaginable. Some remarkable specimens of this description, principally taken from my father's collection, are delineated and described by Haidinger in the third volume of Brewster's Journal. It also occurs stalactitic, botryoidal, mammillated, and amorphous, under the latter form being frequently variegated. Certain varieties, particularly those from Gunnis Lake and St Austle in Cornwall, from the splendid tarnish-colours they occasionally assume, have been termed peacock-copper ore.

Copper pyrites is the most abundant ore of the Cornish mines. Though it there occurs associated with tin, forming veins in killas, and accompanying buntkupfererz, galena, grey copper, and blende, it has nevertheless been worked only at a comparatively late period; for the old miners used to abandon their tin mines when, as they proceeded downwards, the copper became more abundant. The great repository of copper at Fahlun in Sweden consists of extensive masses of this species, which are surrounded by a coating of serpentine, and imbedded in gneiss. At Rammelsberg near Goslar, in the Hartz, it forms a bed in grauwacke-slate, along with iron-pyrites, galena, blende, and minute portions of silver and gold. Well defined crystals are found in the Kurprinz mine at Freyberg in Saxony, and many others in different continental districts, the Bannat, Hungary, Thuringia, &c.

In the year ending 30th June 1822, 104,522 tons of copper ore were raised in Cornwall, which sold for L.663,085, and yielded 9140 tons of pure copper. In 1826, 117,308 tons were raised, which sold for L.788,971, and yielded 9026 tons of metallic copper; and in 1832, 137,357 tons of copper ore were raised, which sold for L.825,612, and produced 11,947 tons of metallic copper. The whole produce of Great Britain and Ireland amounts to about 14,500 tons of copper, five-sixths of which thus appear to be raised from the mines of Cornwall alone, and by much the larger portion, no doubt, in the form of copper pyrites. The enormous expense of fuel in that district, and the difficulty thereby occasioned of keeping the more extensive workings free of water, is however a most serious drawback on the profits of Cornish mining.

Though copper pyrites occurs in vast profusion, it is by no means a rich ore; what is picked for sale at Redruth rarely yielding twelve, generally only seven or eight, and occasionally so little even as three or four per cent. of metal. In the latter case, such poverty of ore is only made up by its facility of transport, the moderate expense of fuel, or the con-

venience of smelting. Its richness may in general be judged of by the colour; if of a fine yellow hue, and yielding readily to the hammer, it may be considered a good ore; but if hard and pale yellow, it is assuredly a poor one, being mixed with iron pyrites. The crystallized varieties are always rich. Though its colour is somewhat brighter than that of iron pyrites, the two may frequently be confounded. It yields, however, to the knife, which iron pyrites does not, and is decidedly harder than that mineral. Iron pyrites, moreover, most commonly occurs crystallized; copper pyrites rarely so. Iron pyrites is subject to decomposition; copper pyrites only to tarnish. Iron pyrites does not afford a green solution in nitric acid, while copper pyrites does so in a few minutes. From gold it is readily distinguished by its fracture and tenacity—it being brittle, whereas gold is malleable.



## ORDER GLANCE.

### TIN PYRITES.

Hexahedral Copper Glance, *M.* Sulphuret of Tin, *P.* Zinnkies, *W.* Etain Sulfuré, *H.*

Sp. Gr. 4·3—4·4. H. = 4·0.

Tessular. Crystalline form, the cube; massive. *Colour* steel-grey when pure; often yellowish from an admixture of copper pyrites. *Opake.* *Lustre* metallic. *Streak* black. *Fracture* uneven. *Brittle.* Two analyses yielded to Klaproth

Tin	34·0	26·5
Copper	36·0	30·0
Iron	2·0	12·0
Sulphur	25·0	30·5

Before the blowpipe sulphur is driven off, after which it fuses readily into a black scoria. It is soluble in nitro-muriatic acid, with the exception of the sulphur, which is precipitated.

#### OBSERVATIONS.

Tin pyrites occurs only in Cornwall, and that principally at Huel Rock in the parish of St Agnes, where it forms a considerable vein, and is accompanied by pyrites, blende, and other minerals. In the old Cornish collections at Menabilly and Scorrier, crystals of tin pyrites are preserved, which assume apparently a hexahedral form; their surfaces however are dull. Its peculiar yellowish tinge frequently imparts to the mass the aspect of bronze or bell-metal, and thence its name of *bell-metal ore*. This, together with its black streak, serves sufficiently to distinguish it from either copper-pyrites or fahlerz.

### FAHLERZ.

Tetrahedral Copper Glance, *M.* and *J.* Grey Copper, Fahlerz, *P.* Fahlerz, Schwarzerz, *W.* Kupferfahlerz, Schwarzgiltigerz, *Haus.* Fahlerz, *L.* Cuivre Gris, *H.*

Sp. Gr. 4·4—5·2. H. = 3·0—4·0.

Tessular. FIG. 156. Inclination of *l* to *l* = 109° 28', of *l* to *l'* = 146° 27', of *P* to *P* = 70° 32'. *Colour* varying between

steel-grey and iron-black. *Lustre* metallic. *Streak* unchanged, sometimes inclining to brown. Rather brittle. *Cleavage* octahedral, imperfect. *Fracture* more or less conchoidal.

	<i>Fahlerz.</i>	<i>Schwarzerz.</i>
Contains Copper	48·0	40·25
Arsenic	14·0	0·75
Antimony	0·0	23·00
Sulphur	10·0	18·50
Iron	25·5	13·50
Silver	0·5 Klaproth.	0·30 Klaproth.

Other varieties contain the same ingredients in equally various proportions; some include also zinc, mercury, lead, and even as much as  $13\frac{1}{2}$  per cent. of silver. A variety from Hohenstein contains gold; and that of Guadalcanal in Spain from one to ten per cent. of platina. Their comportment before the blow-pipe consequently differs; some yielding antimony, others arsenic, and the remainder melting in different ways; they, however, all afford a globule of copper after roasting. When reduced to powder they are almost entirely soluble in concentrated nitric acid.

## OBSERVATIONS.

The largest individuals of this species occur in some of the Cornish mines near St Austle; generally in tetrahedral crystals, with dull, rough surfaces. At Andreasberg in the Hartz, Cremnitz in Hungary, Freyberg in Saxony, Kapnick in Transylvania, and Dillenburg in Nassau, it not only presents more complicated crystallizations, but a greatly brighter and more brilliant aspect. These belong to the *Fahlerz* of Werner, or *arsenical grey copper* of the English mineralogists, which approaches more to steel-grey, presents an uneven fracture, and possesses lower degrees of lustre; while the *Schwarzerz*, *black copper*, or *antimonial grey copper*, rarely occurs crystallized, is nearly iron-black, and has a bright, more or less perfect conchoidal fracture. Some varieties of these two can be distinguished at first sight; and the marked diversity in their chemical composition would seem to demand a decided separation. There are other varieties, however, which present such intermediate stages as to render all attempts at reducing the differences to fixed limits impossible. The principal localities of *Schwarzerz* are the old mines of Schwatz in the Tyrol; Kapnick in Transylvania; Siberia; and Clausthal in the Hartz, where it occurs imbedded in red manganese. It accompanies copper pyrites, and is worked as an ore of copper; occasionally also for the silver it contains. The *weiss kupfererz* of Werner, or *cuivre pyriteux arsenical* of Levy, appears also to belong to this species.



## BOURNONITE.

Di-prismatic Copper Glance, *M.* Di-prismatic Melane Glance, Axifrangible Antimony-Glance, or Bournonite, *J.* Triple Sulphuret, *P.* Schwarz-spiesglaserz, *W.* Bleifahlerz, Spiessglanz-bleierz, *Haus.* Bournonit, *L.* Antimoine Sulfuré Plombocuprifère, *H.*

Sp. Gr. 5·7—5·8. H. = 2·5—3·0.

Prismatic. FIG. 157. Inclination of *o* to *K* = 133° 34', of *d* to *K* = 136° 50', of *n* to *n* over *r* 96° 31'. Colour steel-grey, inclining to lead-grey or iron black, according to the surface. Lustre metallic. Streak unchanged. Brittle. Cleavage imperfect. Fracture conchoidal or uneven. Consists of

	Cornwall.		Clausthal.
Antimony	24·23	28·5	19·75
Lead	42·62	39·0	42·50
Copper	12·80	13·5	11·75
Iron	1·20	1·0	5·00
Sulphur	17·00 Hatchett.	16·0 Klap.	18·00 Klap.

Before the blowpipe it decrepitates, emits for some time white sulphureous vapours, and ultimately melts into a black globule. In a strong heat the charcoal becomes covered with oxide of lead. It is readily soluble in heated nitric acid.

## OBSERVATIONS.

This species was first noticed in the parish of Endellion, near Redruth in Cornwall, and was described by Count Bournon under the name of *endellionite*; subsequently, however, in compliment to the Count, it was named bournonite, by which title it is best known. The most magnificent crystals of bournonite are found in the mines of Neudorf in the Hartz, where they occasionally exceed an inch in diameter. It occurs accompanying quartz, fahlerz, and phosphorescent blende, at Kapnick in Transylvania, in compressed crystals, which, from the peculiar arrangement of its individuals, produce the variety termed in Germany *radelerz* or wheal ore. Also with pearl-spar and quartz at a mine near Servos in Piemont; at Braunsdorf and Gersdorf in Saxony; at Clausthal and Andreasberg in the Hartz; in some of the gold mines of Hungary and Transylvania; and in Peru.

The *prismatoidal copper-glance* of Mohs from St Gertraud, near Wolfsberg in Carinthia, is so closely allied to the present species as not to require a separate place. It is generally somewhat decomposed, externally coated with oxide of iron, and, when fresh broken, presents a blackish lead-grey colour. The massive compact variety from Ekaterineburg in Siberia, which has always been classed with bournonite, resembles the above in almost every particular.

When in sufficient quantity, it is employed as an ore of copper.

## VITREOUS COPPER.

Prismatic Copper Glance, *M.* Vitreous Copper, Sulphuret of Copper, *P.* Kupferglas, *W.* Kupferglanz, *Haus.* and *L.* Cuivre Sulfuré, *H.*

Sp. Gr. 5.5—5.8. H. = 2.5—3.0.

Prismatic. FIG. 158. Inclination of *o* to *o* contiguous =  $119^{\circ} 35'$ ; of *a* to *a* over *o* =  $65^{\circ} 28'$ ; of *d* to *d* over *p* =  $63^{\circ} 48'$ . Most commonly maced. Colour blackish lead-grey, with an occasional blue or green superficial iridescence. Lustre metallic. Streak unchanged, sometimes shining. Very sectile. Face *s* streaked parallel to the axis, sometimes deeply furrowed. Cleavage imperfect. Fracture conchoidal. It consists of

	Rothenburg.	Siberia.	Cornwall.
Copper	76.5	78.50	84.0
Sulphur	22.0	18.50	12.0
Iron	0.5	2.25	4.0
Silica	0.0 Klap.	0.75 Klap.	0.0 Chenevix.

the proportion of sulphur and copper, according to the Berzelian formula, being as 20.27 to 79.73. In the oxidating flame of the blowpipe it melts and emits sparks, and, when the sulphur is driven off, affords a globule of copper. In heated nitric acid the copper is dissolved, and the solution assumes a green colour; but the sulphur remains undissolved.

## OBSERVATIONS.

Magnificent crystalline specimens of vitreous copper are met with abundantly, though almost exclusively, in Cornwall; while the more compact and massive varieties are found also in Siberia, Hessa, Saxony, the Bannat, and, according to Silliman (xv. 133), in Nova Scotia.

It forms veins and beds with other ores of copper, and is highly prized by the miner. Some of the Cornish collections contain splendid suites of this elegant, though complex, crystallized mineral. Vitreous copper is at once distinguished from either bournonite or fahlerz by its comportment before the blowpipe, and the green solution it produces with nitric acid; and from red silver ore by the colour of its streak, which resembles that of the mineral, while red silver ore presents a fine cochineal-red hue.

The *argent en epis*, or *cuivre spiciforme* of Haüy, from Frankenberg in Hessa, is supposed to be vegetable matter impregnated with black sulphuret of copper.



## TENNANTITE.

Tennantite, *J.* and *P.*

Sp. Gr. 4.3—4.4. H. about 4.0.

FIG. 159. A combination of the rhomboidal- and trigonal-dodecahedron. Inclination of  $o$  to  $o = 120^\circ$ , of  $l$  to  $l' = 109^\circ 28'$ . Colour blackish lead-grey. Opake. Lustre metallic. Streak reddish-grey. Cleavage parallel to  $o$ , the faces of the dodecahedron, but imperfect. Fracture uneven. Brittle. Contains copper 45.32, arsenic 11.84, iron 9.26, sulphur 28.74, silica 5.00—Phillips.

It decrepitates slightly before the blowpipe, burns with a blue flame, emits copious arsenical vapours, and at last melts into a black scoria, which acts upon the magnet.

## OBSERVATIONS.

Tennantite is a species exclusively Cornish. It usually occurs in small but very splendid crystals investing other ores of copper, in veins which traverse granite and clay slate, in the mines near Redruth and St Day. The regular dodecahedron, the cube with its edges replaced, and the octahedron and dodecahedron in various combinations, are its most frequent forms; but it has not been met with massive.

## SULPHURET OF SILVER.

Hexahedral Silver Glance, *M.* and *J.* Sulphuret of Silver, Vitreous Silver, *P.* Glaserz, *W.* Glanzerz, *Haus.* Silberglanz, *L.* Argent Sulfuré, *H.*

Sp. Gr. 6.9—7.2. H. = 2.0—2.5.

Tessular. Dodecahedron. Colour blackish lead-grey. Lustre metallic. Streak shining. Malleable and sectile, yielding readily to the knife. Cleavage, traces parallel to the faces of the dodecahedron. Fracture imperfect. The Freyberg variety yielded to Klaproth silver 85.0, and sulphur 15.0; although the Berzelian formula indicates its proportion as 87.04 to 12.96. A small fragment presented to the blowpipe intumesces, and yields immediately a globule of silver. It is soluble in dilute nitric acid; and when isolated and rubbed, acquires resinous electricity.

## OBSERVATIONS.

This is a valuable silver ore when obtained in sufficient quantity; but, except at Annaberg, Joachimsthal, and other mines of the Erzgebirge, Schemnitz and Kremnitz in Hungary, Freyberg, and Mexico, it is

comparatively of rare occurrence. At Freyberg it accompanies other ores of silver, in veins which traverse gneiss; and most of the precious metal obtained at Guanaxuato in Mexico is extracted from this species. It occurs both crystallized and massive, assuming also various reticulated, filiform, arborescent, and capillary shapes. The Wernerian collection at Freyberg contains a splendid suite of the sulphurets of silver, many of which were obtained at Joachimsthal.

### GALENA.

Hexahedral Lead Glance, *M.* Hexahedral Galena, or Lead Glance, *J.* Sulphuret of Lead, Blue Lead, *P.* Bleiglanz, Blau-Bleierz, *W.* Bleischweif, *Haus.* Plomb Sulfuré, *H.*

Sp. Gr. 7·4—7·6. H. = 2·7.

Tessular. FIGS. 8, 9, and 141. *Colour* pure lead-grey. *Lustre* perfect metallic, particularly on the faces of cleavage. *Streak* unchanged. Easily frangible. *Cleavage* highly perfect, and readily obtained parallel to the faces of the cube. Surface of the crystals occasionally tarnished.

According to Thomson, it contains 85·13 lead and 13·02 sulphur, with about a half per cent. of iron; while by the chemical formula the proportion is as 86·55 to 13·45. Before the blow-pipe it decrepitates; but when heated with precaution, it melts, and yields, after the sulphur has been driven off, globules of metallic lead.

### OBSERVATIONS.

Galena is a mineral of very frequent occurrence, forming veins and beds both in primary and secondary rocks. Veins in gneiss are its repositories at Freyberg in Saxony; veins in clay slate, at Clausthal and Neudorf in the Hartz; while at Feistritz and other places in Styria, it forms beds in the same description of rock. The grauwacke at Leadhills and the Killas of Cornwall are equally interspersed with veins of galena; while the rich repositories of Derbyshire, Cumberland, and the northern districts of England, as well as those of Bleiberg, and the neighbouring localities in Carinthia, are contained in transition or mountain limestone. These last are remarkable for the purity of their lead, while that obtained from the former generally contains small portions of silver.

The general forms of its crystals are the cube and octahedron, with various intervening modifications. Individuals of very large dimensions have been obtained at Dufton and Alston Moor in England; at Pfaffenberg, near Neudorf in the Hartz; in Transylvania and Saxony. Leadhills is its principal Scottish locality, though it has been noticed also in large octahedral crystals near Inverkeithing in Fifeshire, at East Calder, the Isle of Isla, and elsewhere. It is associated in the English localities



with calcareous and fluor spars, with blende, calamine, barytes, witherite, and pearl spar; in Greenland with cryolite and sparry iron; at Sala in Sweden it forms veins in primitive limestone; and at Przibram in Bohemia traverses clay-slate.

Compact galena chiefly occurs at Freyberg in Saxony, in the Hartz, Carinthia, and at Leadhills in Scotland. The specular galena consists of an extremely thin coating of lead on quartz or some other substance, and exhibits an appearance of polish, and a lustre, which procured for it the name of slickenside or looking-glass-lead-ore.

In galena a beautiful iridescent tarnish is frequently observable; and, what is remarkable, it is, as in some other minerals, confined to the faces of the secondary forms; those of the octahedron being tarnished, while the hexahedral faces are not. Sometimes also the crystals are so loaded with sulphur, that it may be seen in minute but very perfect individuals, both superficially, and pervading the mass. The fine-grained variety from Dufton contains so much sulphur that it burns with a blue flame on exposure to the candle. Few minerals present the phenomena of parasitic formations more frequently than this does. *Blue lead*, for instance, is evidently pseudomorphic of phosphate of lead. It is the *plomb sulfuré épigène* of Haüy and the *blau bleierz* of Werner; and is peculiar to Wheal Hope in Cornwall, to one of the old mines near Poullouen in France, and to Zschoppau in Saxony. Galena is distinguished from plumbago by its weight, and by its not affording distinct traces on paper; from sulphuret of molybdena also by its structure, which is never foliated; and from the brilliant metallic varieties of blende, by the surfaces of its crystals resuming their lustre instantly when breathed upon, while those of blende remain dull for some time.

The annual produce of the British lead mines is about 48,000 tons of metal, most of which is obtained from this ore. Galena also occasionally contains small portions of silver and gold, and in such cases is frequently smelted for the sake of extracting the more precious metals. Lead is obtained from galena by roasting, which drives off the sulphur and oxidizes it; coke or other inflammable matter is then added, which decomposes the metallic oxide, and the lead sinks to the bottom of the furnace in a reduced state. Silver, when in sufficient quantity to repay the expense, may then be separated by the process of cupellation. Its ready fusibility, its weight, and softness, render lead a highly important metal; and its multifarious uses in the form of pipes, sheets for house-roofing, shot, &c. &c. are too well known to require enumeration in this place. It unites also with many other metals, and thus tends to the formation of several valuable alloys.

The *sulphuret of lead and antimony*, and the *sulphuret of lead, antimony, and silver*, may with propriety be classed along with this species; the difference in their chemical composition being insufficient to distinguish them, otherwise than as varieties.

## FOLIATED TELLURIUM.

Pyramidal Tellurium Glance, *M.* Prismatic Tellurium Glance, *M.* and *J.* Black Tellurium, *P.* Nagyager-erz, *W.* Blattertellur, *Haus.* and *L.* Tellure Natif Aurifère et Plombifère, Tellure Natif Auro-Plombifère, *H.*

Sp. Gr. 7.0—7.2.  $H. = 1.0—1.5.$

Pyramidal. FIG. 160. Inclination of  $b$  to  $b = 140^\circ$ , of  $c$  to  $c = 122^\circ 50'$ . Generally foliated. *Colour* blackish lead-grey. *Lustre* metallic. *Streak* unchanged. *Cleavage* perfect parallel to  $P$ . Highly flexible when in thin laminæ. Very sectile. It contains tellurium 32.2, lead 54.0, gold 9.0, silver 0.5, copper 1.3, sulphur 3.0—Klaproth.

It fuses readily before the blowpipe, communicating to the flame a bluish tinge; emits white fumes, which are deposited upon the charcoal; and yields a malleable metallic globule. With borax it affords a bead of gold, containing a little silver; and in nitro-muriatic acid is soluble without much difficulty.

## OBSERVATIONS.

This species is denominated prismatic tellurium glance in Haidinger's translation of Mohs. He now however considers it as belonging to the pyramidal system. It occurs in foliated masses and crystalline plates, associated with gold, blende, and silicate of manganese, at Nagyag in Transylvania; and accompanying antimony ores at Offenbanya in the same country. It is prized for the gold it contains.

## SULPHURET OF MOLYBDENA.

Rhombohedral Molybdena Glance, *M.* Rhomboidal Molybdena, *J.* Sulphuret of Molybdena, *P.* Wasserblei, *W.* Molybdanglanz, *L.* Molybdene Sulfuré, *H.*

Sp. Gr. 4.4—4.6.  $H. = 1.0—1.5.$

Rhombohedral. In extremely flat six-sided prisms. *Colour* pure lead-grey. *Lustre* metallic. *Streak* unchanged, slightly tinged green. *Cleavage* very perfect, parallel to the terminal face of the prism. Thin laminæ are highly flexible, but not elastic. Very sectile; feels greasy; and leaves traces on paper. Consists of molybdena 60.0, and sulphur 40.0—Bucholz.

It neither fuses, nor is reduced, before the blowpipe, but emits sulphureous fumes, which are deposited upon the charcoal. It is soluble with effervescence in nitric acid, but leaves a grey residue; and it deflagrates with nitre.



less volatile before the blowpipe than grey antimony, and does not, like that mineral, rapidly and entirely disappear when fused on charcoal. Its specific gravity is also greater than that of antimony.

The *native sulphuret of bismuth* described by Mr R. Warrington in the *Annals of Philosophy* for October 1831, is evidently an impure Cornish variety of this species.

### NEEDLE ORE.

Acicular Bismuth-Glance, Needle-Ore, *J.* Plumbo-Cupriferos Sulphuret of Bismuth, *P.* Nadelorz of the Germans. Bismuth Sulfuré Plumbo-Cuprifère, *Levy*.

Sp. Gr. 6.1—6.15. H. = 2.0—2.5.

Form undetermined. In irregular imbedded acicular crystals, of a blackish lead-grey colour, with occasionally a yellowish tarnish. *Lustre* metallic. *Cleavage* imperfect, and *fracture* uneven. Contains bismuth 43.20, lead 24.32, copper 12.10, nickel 1.58, tellurium 1.32, sulphur 11.58, gold 0.79—John. Before the blowpipe it gives off sulphureous vapours, and melts; emitting at same time numerous sparkling globules. The metallic bead which remains contains copper, and communicates a greenish-blue colour to glass of borax. It is soluble in nitric acid.

#### OBSERVATIONS.

Needle ore occurs imbedded in white quartz, accompanying gold, malachite, and galena, at Beresof, near Ekaterineburg, in Siberia.

### GRAPHIC TELLURIUM.

Prismatic Antimony Glance, *M.* Graphic Gold Glance, or Graphic Tellurium, *J.* Graphic Gold, *P.* Schriftez, *W.* Schrift Tellur, *L.* Tellure natif aurifère et argentifère, Tellure natif auro-argentifère, *H.*

Sp. Gr. 5.7—5.8. H. = 1.5—2.0.

Prismatic. In prismatic acicular crystals intersecting each other at angles of 60° and 120°. *Colour* pure steel-grey. *Lustre* metallic. *Streak* unchanged. *Cleavage* highly perfect parallel to the axis. *Fracture* uneven. Very sectile. Consists of tellurium 61.35, gold 28.36, silver 10.29—Klaproth.

It fuses readily into a grey globule, colouring the flame greenish-blue, and giving off fumes which form on the charcoal a white oxide; on continuing the blast for some time, a ductile metallic globule is obtained. It is soluble in nitric acid.

## OBSERVATIONS.

The German name of *Schrifterz* was applied to this species by Werner, in allusion to the peculiar disposition of its crystals, which are frequently arranged in rows more or less resembling graphic delineations. Several different crystalline forms have been noticed, but the individuals being small, and in this manner disseminated and engaged, they have not yet been satisfactorily described. It occurs accompanying gold in narrow veins, which traverse porphyry, at Offenbanya in Transylvania; also at Nagyag in the same country. Its large proportion of gold renders this a highly valuable ore.

## GREY ANTIMONY.

Prismatoidal Antimony Glance, *M.* Prismatic Antimony Glance, or Grey Antimony, *J.* Sulphuret of Antimony, *P.* Grauspiessglaserz, *W.* Grauspiessglanzerz, *Haus.* Antimoine sulfuré, *H.*

Sp. Gr. 4.2—4.7. H. = 2.0.

Prismatic. FIG. 162. Inclination of P to P =  $109^{\circ} 16'$ ; of P to P on the opposite side =  $108^{\circ} 10'$ ; of P to *m* =  $155^{\circ} 29'$ ; of *m* to *m* =  $90^{\circ} 45'$ . Colour lead-grey, inclining to steel-grey, subject to tarnish. Lustre metallic. Streak unchanged. Cleavage highly perfect parallel to the axis. Sectile. When massive, presenting a long columnar composition. It consists of

Antimony	74.06	73.77	74.0
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Sulphur	25.94 Davy.	26.23 Thomson.	26.0 Bergmann.
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Its chemical formula corresponds to 72.77 antimony, and 27.23 sulphur. It fuses at the flame of a taper, and before the blow-pipe is absorbed by the charcoal, emitting at same time a strong sulphureous odour, and white fumes.

## OBSERVATIONS.

It occurs principally in veins, which in some places, as at Wolfsthal in the county of Stollberg in the Hartz, and at Posing near Presburg in Hungary, are almost entirely composed of grey antimony. Felsőbanya, Schemnitz, and Cremnitz, in Hungary, are, however, its most celebrated localities, being frequently found in these mines in distinct diverging prisms several inches in length, associated with, and penetrating crystals of barytes and other minerals. It occurs also fibrous and laminated in Dumfriesshire; massive in Cornwall; and compact, particularly at Magurka in Hungary. When in delicate fibres it occasionally presents a plumose, woolly, or felt-like appearance; forming the *Federerz* of German mineralogists.

It is almost the only ore of antimony which is found in sufficient quantity for commercial purposes, and is prepared for the market by simple fusion. It is employed in the manufacture of several alloys, in the fabrication of types, and in medicine.



## JAMESONITE.

Axotomous Antimony Glance, *M.* Jamesonite, *Haidinger*. *Rose* in *Edin. New Phil. Jour.* Jan. 1827.

Sp. Gr. 5.5—5.8. H. = 2.0—2.5.

In rhomboidal four-sided prisms of  $101^{\circ} 20'$  and  $78^{\circ} 40'$ . Colour steel-grey. Lustre metallic. Streak unchanged. Sectile. Cleavage perfect perpendicular to the axis of the prism; less so parallel to it. It contains, according to *Rose*,

Sulphur	22.15	22.53
Lead	40.75	38.71
Antimony	34.40	34.90
Iron	2.30	2.65

and a little zinc and copper.

## OBSERVATIONS.

Jamesonite, like the preceding species, occurs both in acicular diverging crystals, and in fibrous masses of considerable dimensions. Its perfect cleavage perpendicular to the axis of the prism was first observed by *Mohs*, who consequently distinguished it as a particular species. It occurs principally in Cornwall associated with quartz and minute crystals of Bournonite; occasionally also in Siberia; and, it is said, in Hungary.

## SULPHURET OF SILVER AND ANTIMONY.

Peritomous Antimony Glance, *M.* Sulphuret of Silver and Antimony, *P.* Schwefel-Silber und Antimon, Argent Sulfuré Antimonifère et Cuprifère, *Lévy*.

Sp. Gr. 5.5—5.6. H. = 2.0—2.5.

Prismatic. Fig. 167. Inclination of  $x$  to  $x = 130^{\circ} 8'$ , of  $M$  to  $M = 100^{\circ} 8'$ . Colour light steel-grey, approximating to silver-white. Lustre metallic. Cleavage perfect parallel to  $M$ . Surface striated longitudinally. Yields easily to the knife.

It is supposed to consist chiefly of antimony, sulphur, silver, and copper. Before the blowpipe it emits copious white vapours, and a slight sulphureous odour, after which a white metallic globule remains.

## OBSERVATIONS.

This very rare mineral is the *Schilfglaserz* of Freisleben, the *mine d'argent grise antimoniale* of Romé de l'Isle. It occurs with sulphuret of silver, carbonate of iron, and galena, in the Himmelsfurst mine at Freyberg in Saxony; and occasionally also at Kapnick in Transylvania. Its mechanical division is highly characteristic; as, according to *Levy*, it cleaves parallel to the lateral faces of three rhomboidal prisms, two of which have their axes parallel; while in other substances which have

cleavages parallel to the lateral faces of two rhomboidal prisms, the axes are either perpendicular to one another, or inclined at different angles.

### BERTHIERITE.

*Haidingerite of Berthier.* Berthierit, L. Ann. de Chimie, tom. 35.

Massive, or presenting elongated prisms with a pretty distinct longitudinal cleavage, imbedded in a mixture of blende, calcareous spar, and pyrites. *Colour* dark steel-grey, inclining to pinchbeck brown. *Lustre* metallic, but less splendid than grey antimony. It contains sulphur 30·3, antimony 52·0, iron 16·0, zinc 00·3.—Berthier. It fuses readily before the blowpipe, emits antimonious vapours, and forms a black slag which acts on the magnet; and with fluxes exhibits the usual indications of the presence of iron. It is quickly dissolved in muriatic acid, giving out sulphuretted hydrogen.

#### OBSERVATIONS.

This mineral was discovered and described by M. Berthier of Paris, who named it Haidingerite, in compliment to his friend Mr Haidinger; but that gentleman's name being already associated with another species, he (Mr H.) proposed its present denomination, in honour of the discoverer. It is found at Chazelles in Auvergne, associated with quartz, calcareous spar, and iron pyrites; and yields antimony of such inferior quality, that manufacturers cannot use it.

### ZINKENITE.

Brewster's Journal, VI. 17.

Sp. Gr. 5·3—5·35. H. = 3·0—3·5.

FIG. 123. In regular six-sided prisms, terminated by flat six-sided pyramids. Inclination of  $r$  on  $r = 120^\circ$ ,  $P$  on  $r = 102^\circ 42'$ . The faces of the prism are usually striated deeply in a longitudinal direction; those of the pyramid, though not furrowed, are uneven. *Colour* steel-grey. *Lustre* bright metallic. *Streak* unchanged. No traces of cleavage. *Fracture* uneven. According to H. Rose, it contains sulphur 22·58, lead 31·84, antimony 44·39, and a little copper. It therefore consists of one atom sulphuret of lead, and two atoms sulphuret of antimony. When heated alone on charcoal it decrepitates briskly, and melts as readily as grey antimony: small metallic globules are formed, which are entirely volatile on the blast being continued, while



the charcoal is covered with a white coating of oxide of lead. With soda it yields globules of metallic lead.

OBSERVATIONS.

Zinkenite occurs in the antimony mine of Wolfsberg, near Stolberg in the Hartz, and was named by its original discoverer Dr Gustavus Rose, in honour of his friend Mr Zinken, the director of the Anhalt mines. It much resembles both grey antimony and bournonite in colour and fracture, but may be distinguished from them by its superior hardness and specific gravity. Its crystals are aggregated in groups, which present a columnar composition, and occur on a massive variety of the same species in quartz. Their length often exceeds half an inch, their breadth two or three lines; but frequently they are extremely thin, and form fibrous masses.

Zinken has latterly discovered another ore of antimony in the same mines, the specific gravity of which is slightly higher, and its hardness considerably lower than the above. He has given a notice of it in Pogendorff's Annalen, vol. xxii.

BRITTLE SILVER ORE.

Prismatic Melane Glance, *M.* Rhomboidal Silver Glance, or Brittle Silver Glance, *J.* Brittle Sulphuret of Silver, *P.* Sprodglaserz, *W.* Sprodglanzerz, *Haus.* Schwarzgiltigerz, *L.* Argent Noir, Argent Antimonié Sulfuré Noir, *H.* Argent Sulfuré Fragile, *Levy.*

Sp. Gr. 5.9—6.4. H. = 2.0—2.5.

Prismatic. FIG. 163. Inclination of *o* to the adjoining *o* = 115° 39', of *P* to *P* over *o* = 104° 19', of *d* to *d* over *p* = 107° 47'. Crystals most frequently maced. Colour iron-black, inclining to lead-grey. Lustre metallic. Streak unchanged. Sectile. Cleavage in the directions of *o* and *p*, but imperfect. Contains

Silver	66.5	68.54
Antimony	10.0	14.68
Iron	5.0	0.00
Sulphur	12.0 Klaproth.	16.42 H. Rose.

with a little copper and arsenic. Before the blowpipe it melts, the sulphur and antimony fly off, and a dark-coloured metallic globule remains, which may be reduced by the addition of soda or silica. It is soluble in dilute nitric acid.

OBSERVATIONS.

This species forms veins along with other ores of silver in the mining districts of Freyberg, Schneeberg, and Johanngeorgenstadt in Saxony; at Przibram and Ratiborwitz in Bohemia; at Schemnitz and Cremnitz

in Hungary; at Andreasberg in the Hartz; and in Mexico. It is a valuable ore of silver; and enriches the Wernerian and several other Freyberg collections with most splendid suites of specimens. It is the compact and massive variety of this species to which Werner's name of *Schwarz-giltigerz* particularly applies. The *weiss-giltigerz*, again, is merely a mechanical mixture of brittle silver, galena, and grey antimony. The richer it is in silver, the more nearly it approaches to this species, while, in the contrary case, it resembles compact galena or antimony; so that evidently it cannot be considered a particular species.

### FLEXIBLE SULPHURET OF SILVER.

Flexible Sulphuret of Silver, *P.* Argent Sulfuré Flexible, *Bournon*.

In minute flat crystals; massive. *Colour* externally almost quite black. *Lustre* metallic. *Streak* shining. Flexible when in thin laminæ, and easily separable into them. *Cleavage* perfect in one direction. Yields readily to the knife. Consists, according to Wollaston, of silver, sulphur, and a little iron.

#### OBSERVATIONS.

This is a rare mineral, having hitherto been met with only in Hungary and Saxony, and even there in very small quantity.

### SELENIURET OF SILVER AND COPPER.

Seleniuret of Silver and Copper, *P.* Selenkupfer silber of the Germans. Cuiyre Sélénié Argental, *H.* Eukairite, *Berzelius* and *L.*

Massive: disposed in thin superficial black metallic films, staining the calcareous spar in which it is contained. *Colour* between silver-white and lead-grey. Opake. *Lustre* metallic. *Streak* shining. Soft. It is composed of copper 23.05, selenium 26.0, silver 38.93, earthy matter 8.90. Before the blowpipe it emits copious vapours of selenium, and on charcoal fuses readily into a grey metallic globule, which imparts a green colour to glass of borax, leaving a bead of seleniuret of silver. It is soluble in boiling nitric acid.

#### OBSERVATIONS.

This extremely rare mineral was discovered and analyzed by Berzelius. It occurs exclusively in the Skrickerum copper mine in Smaland, Sweden, in a serpentine kind of rock, accompanied by and imbedded in calcareous spar.



## ORDER BLENDE.

### SULPHURET OF MANGANESE.

Hexahedral Glance Blende, *M.* Prismatic Manganese Blende, *J.* Sulphuret of Manganese, *P.* Manganblende, *Breit.* Schwarzerz, *Haus.* Manganglanz, *L.* Manganèse Sulfuré, *H.*

Sp. Gr. 3·9—4·05. H. = 3·5—4·0.

Tessular. Massive. *Colour* iron black, tarnished brown on exposure. *Opake.* *Lustre* imperfect metallic. *Streak* green. Sectile. *Cleavage* perfect parallel to the faces of the cube. *Fracture* uneven. Surface rough. Consists of

Protox. of mangan.	82·0	85·0	62·6
Sulphur	11·0	15·0	37·0
Carbonic acid	5·0 Klap.	0·0 Vauq.	0·0 Arfwed.

Before the blowpipe it fuses only on its thinnest edges; and, if reduced to powder, is dissolved when thrown into acid, emitting at same time fumes of sulphuretted hydrogen.

#### OBSERVATIONS.

This very rare mineral occurs chiefly in veins, along with tellurium, quartz, and carbonate of manganese, in the gold mines of Nagyag in Transylvania.

### BLENDE.

Dodecahedral Garnet Blende, *M.* Dodecahedral Zinc Blende, *J.* Blende, Sulphuret of Zinc, *P.* Blende of the Germans. Zinc Sulfuré, *H.*

Sp. Gr. 4·0—4·2. H. = 3·5—4·0.

Tessular. FIG. 164. Inclination of P to P = 120°, of *y* to *y* contiguous = 129° 31'. Structure lamellar or foliated. *Colour* brown, black, red, green, and yellow; seldom bright. Transparent or translucent. *Lustre* adamantine. *Streak* varying with the colour, from white to reddish-brown. Brittle. *Cleav-*

age highly perfect parallel to the faces P of the dodecahedron.

*Fracture* conchoidal. Contains

	Pyrenees.		
Zinc	63·0	62·72	65·50
Iron	3·4	1·50	1·37

Sulphur 33·6 Berthier. 34·00 Gueniv. 32·63 Thomson.

When strongly heated in the oxidating flame of the blowpipe, it gives off vapours of zinc, which form a white coating on the charcoal; but it is infusible even with borax. It dissolves in nitric acid, during which sulphuretted hydrogen is disengaged. Some of the varieties are highly phosphorescent on friction, or when struck with the steel.

#### OBSERVATIONS.

Blende (the *black-jack* of English miners) is a mineral of very frequent occurrence, being met with in beds and veins accompanying most of the ores of silver and lead. It is found not only crystallized under a great variety of forms, and particularly macled, but massive, fibrous, and botryoidal. The dark-coloured crystalline varieties are principally from Derbyshire, Cumberland, and Cornwall, though many splendid specimens have likewise been brought from Transylvania, Hungary, and the Hartz. A transparent bright-yellow variety accompanies bournonite and fahlerz at Kapnick in Transylvania; a still more brilliant one of an oil-green colour occurs at Schemnitz in Hungary; while Sahla in Sweden, Ratiborzitz in Bohemia, and several of the Saxon localities, are celebrated for the splendid brown and black crystals which they afford.

At Przibram it forms radiated or fibrous diverging concretions, which are disposed in massive blende, and contain a small portion of cadmium. A white fibrous blende in botryoidal concretions is met with in Fowey; consolidated mines, and massive varieties, in many other Cornish localities.

Though its forms and colours are extremely various, the perfect cleavage which blende presents parallel to the faces of the dodecahedron, is highly characteristic. It may be distinguished also from those varieties of galena, garnet, and tin, which it occasionally resembles, by the facility with which it yields to the knife. Though this is the most common ore of zinc, and is frequently found in large quantities, the difficulty of extracting the metal, and the limited extent to which it can in consequence be applied, renders blende a production of very little value.

The *marmatite* of Boussingault from the gold works of Marmato in Popayan, S. America (Foggendorff, Ann. xvii. 399), is evidently an impure black variety of this species.



# RED ANTIMONY.

Prismatic Purple Blende, *M.* Prismatic Antimony Blende, or Red Antimony, *J.* Red Antimony, *P.* Rothspiesglaserz, *W.* Rothspiesglanzerz, *Haus.* Antimonblende, *L.* Antimoine Hydro-Sulfuré, Antimoine Oxydé Sulfuré, *H.*

Sp. Gr. 4.5—4.6. H. = 1.0 — 1.5.

Hemi-prismatic. In tufts of capillary crystals, consisting of elongated six-sided prisms. *Colour* cherry-red. *Lustre* adamantine. Feebly translucent. *Streak* brownish red. Sectile. *Cleavage* highly perfect, parallel to the axis of the crystal.

The Braunsdorf variety contains, according to Klaproth, antimony 67.5, oxygen 10.8, sulphur 19.7. It fuses easily upon charcoal, by which it is absorbed, and at last is entirely volatilized. It becomes covered with a white coating when immersed in nitric acid.

## OBSERVATIONS.

This species includes *common red antimony*, and *tinder-ore*; the former comprising such varieties as are crystalline, the latter those in which the individuals are capillary, and so interlaced as to present flakes resembling tinder. It occurs in veins with quartz, accompanying grey and white antimony, at Malazka near Posing in Hungary; at Braunsdorf near Freyberg in Saxony; and at Allemont in Dauphiné. The principal localities of tinder-ore are Clausthal and Andreasberg in the Hartz. It is a rare mineral.

# RED SILVER ORE.

Rhombohedral Ruby-Blende, *M.* Rhomboidal Ruby-Blende, or Red Silver, *J.* Ruby-Silver, *P.* Rothgiltigerz, *W.* Rothgultigerz, *L.* Argent Antimonié Sulfuré, *H.*

Sp. Gr. 5.4—5.9. H. = 2.5.

Rhombohedral. FIG. 165. Inclination of P to P over  $z = 108^{\circ} 18'$ , of  $z$  to  $z$  contiguous =  $137^{\circ} 39'$ . Like tourmaline, its crystals occasionally present different modifications at their opposite extremities. *Colour* varying from cochineal-red to iron-black. Semi-transparent or opaque. *Lustre* adamantine in light-coloured varieties; more inclining to metallic in such as are dark. *Streak* different shades of cochineal-red, according to the colour; sometimes aurora-red. Sectile, yielding readily to the knife. *Cleavage* parallel to P, frequently distinct, sometimes scarcely observable. *Fracture* conchoidal.

Contains Silver	58.95	58.0
Antimony	22.84	23.5
Sulphur	16.61 Bonsdorf.	16.0 Thenard.

The Berzelian formula corresponds to 58.98 silver, 23.47 antimony, and 17.55 sulphur. It decrepitates before the blow-pipe, melts, emits fumes of sulphur and antimony, and ultimately yields a globule of silver. It is soluble in dilute nitric acid.

## OBSERVATIONS.

The *light-* and *dark-red silvers* are principally distinguished by colour, though there is also considerable difference in their specific gravity; the light-red seldom exceeding 5.4—5.6, while that of the dark-red amounts to 5.8—5.9. This very beautiful mineral is confined to a small number of localities, though in some of them it is pretty frequent. The light-red varieties, which exhibit by transmitted light the most splendid cochineal hues, are met with principally in the Saxon and Bohemian mining districts of the Erzgebirge, particularly at Marienberg, Annaberg, and Johanngeorgenstadt in Saxony, and at Joachimsthal in Bohemia, usually associated with other ores of silver, galena, blende, pyrites, and arsenic; while the dark-red ones occur chiefly with calcareous spar, native arsenic, and galena, at Andreasberg in the Hartz. Freyberg in Saxony, Schemnitz and Nagybanya in Hungary, Guadalcanal in Spain, Kongsberg in Norway, and St Marie aux Mines in France, are also well known localities of this species. It was formerly found at Huel Duchy in Cornwall; and from the produce of some of the Mexican mines, vast quantities of the precious metal have been obtained. The imperial collection at Vienna contains the most magnificent specimens of Joachimsthal light-red silver; and there is one in the National Museum at Prague, consisting of a group of crystals several inches long, which weighs above six lbs.; these were obtained so lately as the years 1817 and 1822. Werner's collection is extremely rich in the Freyberg varieties; while some of the most splendid groups of dark-red silver which were ever found at Andreasberg, are preserved in the cabinet of Mr Ferguson of Raith. Iron pyrites, with which it is frequently associated, is, from its proneness to decomposition, a dangerous accompaniment to fine groups of red silver;—these, in such cases, falling gradually to pieces, without the possibility of prevention.

Red silver, from its colour, may sometimes be mistaken for red orpiment; but the yellow streak of the latter is sufficiently characteristic, and its specific gravity is also lower. Cinnabar volatilizes before the blowpipe, while red silver forms a metallic globule. As an ore, it has been observed that the dark-red yield a larger proportion of silver than the light-red varieties, but both of them are highly valuable to the smelter.



HEMI-PRISMATIC RUBY BLENDE.

Sp. Gr. 5·2—5·4. H. = 2·0—2·5.

Hemi-prismatic. *Colour* iron-black. Opaque, except when viewed by transmitted light, in which case thin splinters present a deep blood-red hue. *Lustre* intermediate between metallic and adamantine. *Streak* dark cherry-red. *Cleavage* imperfect. *Fracture* imperfect-conchoidal. Surfaces deeply striated. Very sectile. It contains about a third less silver than the preceding species, but in most other respects closely corresponds with it.

OBSERVATIONS.

This used to be comprised among the varieties of dark-red silver, until distinguished, on account of its form, and described as above, by Mohs. The colour and deeply striated surfaces of its crystals give it also occasionally the appearance of Bournonite. It is a very rare mineral, occurring only with argentiferous arsenical pyrites, in one of the mines of Braunsdorf, near Freyberg in Saxony.

CINNABAR.

Peritomous Ruby-Blende, *M.* Prismato-rhomboidal Ruby-Blende, or Cinnabar, *J.* Sulphuret of Mercury, *P.* Zinnober, Quecksilber-Lebererz, *W.* Stinkzinnober Lebererz, *Haus.* Mercure Sulfuré, *H.*

Sp. Gr. 6·7—8·2. H. = 2·0—2·5.

Rhombohedral. Fig. 166.\* Inclination of P to P = 71° 47'. *Colour* cochineal-red, the darker varieties inclining to lead-grey. Semi-transparent or opaque. *Lustre* adamantine, inclining to metallic when dark coloured. *Streak* bright scarlet. *Cleavage* highly perfect parallel to *l*. *Fracture* conchoidal. The faces P streaked horizontally, sometimes deeply so. Consists, according to Klaproth, of

Mercury	84·50	85·00
Sulphur	14·75	14·25

and by the Berzelian formula contains 86·29 mercury, and 13·71 sulphur,—equivalent to a bi-sulphuret. It is soluble in nitro-muriatic acid; and before the blowpipe volatilizes entirely. Fragments placed on live coal, emit fumes of mercury, which at-

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\* From a well-defined crystallized specimen in my father's collection.

tach themselves to a surface of copper when held over it, and communicate to that metal a white metallic colour.

#### OBSERVATIONS.

Cinnabar and *quicksilver-liver-ore* or *lebererz*, which were formerly considered distinct species, possess the same mutual relation as calcareous spar and limestone; cinnabar comprehending all crystallized varieties in which the individuals are discernible, while quicksilver-liver-ore includes such as are massive, and which, being generally mixed with impurities, such as bituminous matter or clay, afford a brownish streak. Its structure is occasionally slaty, but in general it presents a granular or impalpable composition. The best-defined crystals of cinnabar are found in the coal formations of Moschellandsberg and Wolfstein, in the Palatinate; and at Almaden in Spain; though it also occurs in beds traversing gneiss at Reichenau in Upper Carinthia, in *grauwacke* at Dumbrawa in Transylvania, in limestone at Windisch Kappel in Carinthia, and at Neumarktel in Carniola. Well crystallized specimens are mentioned from Japan, Mexico, and Brazil. The principal repositories of this species, however, are Almaden in Spain, and Idria in Carniola, where it occurs almost exclusively massive, and whence it is obtained in large quantities as an ore of mercury. The variety termed *coralinerz*, from the latter locality, consists of curved lamellar concretions, which present the form and structure of fossilized shells.

Cinnabar is the most abundant and most important ore of mercury. When pure, it may be employed in its natural state as a pigment, but it is principally valued for its mercury, which is obtained from it by sublimation. Vermilion is, in fact, pure cinnabar, being a compound of mercury and sulphur in nearly the same proportions as in this species. It is used in colouring red sealing-wax, and is an indispensable article to the painter.



## ORDER SULPHUR.

### YELLOW ORPIMENT.

Prismatoidal Sulphur, *M.* Orpiment, *P.* Gelbes Rauschgelb, *W.* Rauschgelb, *Haus.*  
Auripigment, *L.* Arsenic Sulfuré Jaune, *H.*

Sp. Gr. 3·4—3·6. H. = 1·5—2·0.

Prismatic. FIG. 168. Inclination of *o* to *o*, contiguous =  $83^{\circ} 37'$ , of *u* to *u* =  $117^{\circ} 49'$ . Colour several shades of lemon-yellow. Semi-transparent, or translucent on the edges. Lustre metallic; pearly upon the perfect faces of cleavage; the rest resinous. Streak yellow, generally somewhat paler than the colour. Sectile. Thin laminæ flexible, but not elastic. Cleavage highly perfect, parallel to *s*.

Contains Sulphur	38·0	38·14
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Arsenic	62·0 Klap.	61·86 Laugier.
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Its chemical formula corresponds to 39·08 sulphur, and 60·92 arsenic. It burns with a blue flame when exposed to the blow-pipe on charcoal, and emits fumes of sulphur and arsenic. It is soluble, though with difficulty, in the nitric, muriatic, and sulphuric acids.

#### OBSERVATIONS.

Yellow orpiment occasionally occurs in small crystals imbedded in blue clay at Tajowa, near Neusohl in Lower Hungary. Most frequently, however, it forms foliated and fibrous masses; and in this state is met with at Kapnick in Transylvania, at Moldawa in the Bannat, and at Felsobanya in Upper Hungary, where it accompanies realgar and native arsenic in metalliferous veins. It is likewise mentioned as occurring in Mexico and in China; and is employed as a pigment.

## RED ORPIMENT.

Hemi-prismatic Sulphur, *M.* Red Orpiment or Ruby Sulphur, *J.* Realgar, *P.* Rothes  
( Rauschgelb, *W.* Realgar, *Haus.* and *L.* Arsenic Sulfuré Rouge, *H.*

Sp. Gr. 3.5—3.6. H. = 1.5—2.0.

Hemi-prismatic. FIG. 169. Inclination of  $n$  to  $n = 130^\circ 2'$ , of  $g$  to  $g = 113^\circ 20'$ , of  $f$  to  $f$  contiguous =  $105^\circ 34'$ , of  $P$  to the edge between  $g$  and  $g = 113^\circ 16'$ . Colour aurora-red or orange-yellow. Transparent or translucent. Lustre resinous. Streak varying from orange-yellow to aurora-red. Sectile. Yields to the nail. Cleavage parallel to  $g$ , and in other directions, imperfect. Fracture perfect conchoidal.

Contains Sulphur 31.0 30.43

Arsenic 69.0 Klaproth. 69.57 Laugier.

Its chemical formula corresponds to 29.96 sulphur and 70.04 arsenic. Before the blowpipe, and in acids, it comports itself like the preceding species.

## OBSERVATIONS.

Well-defined crystals of this remarkably beautiful mineral are found with ores of silver and lead at Felsobanya in Upper Hungary, at Kapnick and Nagyag in Transylvania, at Joachimsthal in Bohemia, at Schneeberg in Saxony, and at Andreasberg in the Hartz. It also occurs in beds of clay at Tajowa in Hungary, and in small nodules engaged in dolomite at St Gothard in Switzerland. Sometimes it forms minute crystals in the vicinity of active volcanoes; in the Solfatara near Naples, and elsewhere. It is used as a pigment.

## SULPHUR.

Prismatic Sulphur, *M.* and *J.* Sulphur, *P.* Naturlicher Schwefel, *W.* Schwefel, *Haus.*  
and *L.* Soufre, *H.*

Sp. Gr. 1.9—2.1. H. = 1.5—2.5.

Prismatic. FIG. 170. Inclination of  $P$  to  $P = 106^\circ 38'$ , of  $P$  to  $P'$  on the opposite side =  $84^\circ 58'$ , of  $P$  to  $P'' = 143^\circ 17'$ . Colour several shades of sulphur-yellow, sometimes inclining to red or green. Varying from transparent, to translucent on the edges. Lustre resinous. Streak sulphur-yellow, frequently very light. Sectile. Cleavage imperfect and interrupted. Fracture conchoidal, more or less perfect. It is pure sulphur, but is oc-



casionally mixed with bitumen or clay. It acquires resinous electricity by friction, and is easily inflammable, burning with a bluish or white flame according to the low or high degree of temperature, and emitting at same time a pungent smell of sulphurous acid. It is insoluble in water.

## OBSERVATIONS.

This well-known mineral occurs principally in two kinds of repositories; either in gypsum and salt rocks, as in the valleys of Noto and Mazzara in Sicily, at Conil near Cadiz in Spain, and Cracow in Poland; or in the vicinity of active and extinct volcanoes. In the latter case, it is the result of sublimation, forming either crystals in the clefts and cavities of the rock, or crusts, stalactites, and loose efflorescent coatings. In small quantities it is likewise met with in certain metallic veins, as in Savoy, Switzerland, Hanover, and other countries. In Iceland it is deposited by hot springs; and many of the natural medicinal waters both of this and other countries, hold it largely in solution. Sicily produces crystals of this substance, which occasionally exceed two or three inches in diameter. Very fine ones also occur at Conil in Spain; and, though of a smaller size, at the Solfatara near Naples, and on the island of Teneriffe. At Radoboy, near Crapina in Croatia, it occurs in imbedded spheroidal masses of a brown tinge, which is owing to bitumen; and in the dark-reddish coloured sulphur of the Lipari Islands, Stromeyer discovered selenium.

Immense quantities are annually obtained from the sulphur mines of Sicily, the crater of Volcano, and the Solfatara near Naples. The produce of these localities, however, requires to be purified, either by melting or by sublimation, before being applicable to commercial purposes. The sulphur which is manufactured elsewhere, is obtained from iron pyrites. It is of great importance in the arts; being employed in the fabrication of gunpowder, of cinnabar and sulphuric acid, in making casts, certain cements, and in various pharmaceutical preparations. In 1829 302,000 cwts. of rough sulphur were imported into Great Britain, of which no less than 285,000 came from Sicily.

## ORDER RESIN.

### MELLITE.

Pyramidal Melichrone Resin, *M.* Pyramidal Mellilite or Honeystone, *J.* Mellite, *P.*  
Honigstein *of the Germans.* Mellite, *H.*

Sp. Gr. 1.4—1.6. H. = 2.0—2.5.

Pyramidal. FIG. 171. Inclination of P to P =  $118^{\circ} 4'$ , of P to g =  $93^{\circ} 22'$ . Colour honey-yellow, inclining often to red or brown, varying from transparent to translucent. Lustre resinous, inclining to vitreous. Streak white. Cleavage difficultly obtained. Fracture conchoidal. Surfaces of P and g smooth and shining. Sectile.

Consists of Alumina	16.0	14.5
Mellitic acid	46.0	41.4
Water	38.0 Klaproth.	44.1 Wöhler.

It loses colour and transparency when exposed to the flame of a candle, and is soluble in nitric acid.

#### OBSERVATIONS.

The only known locality of mellite is Artern in Thuringia, where it is found in a bed of earthy brown coal, and occasionally accompanied with small crystals of sulphur.

### AMBER.

Yellow Mineral Resin, *M.* Yellow Mineral Resin or Amber, *J.* Amber, *P.* Bernstein *of the Germans.* Succin, *H.*

Sp. Gr. 1.0—1.1. H. = 2.0—2.05.

In irregular masses and grains, generally of a yellow colour, but passing into red, brown, and white, sometimes even black. Transparent or translucent. Lustre resinous. Streak white. Cleavage none. Fracture conchoidal, smooth, and glassy. Surface uneven and rough. Resinous electricity easily produced by friction. Contains



Carbon	80.59	70.68
Hydrogen	7.31	11.62
Oxygen	6.73 Drappier.	7.77 Ure.

The former also noticed minute portions of lime, alumina, and silica. It burns with a yellow flame, emits an agreeable odour, and leaves a black shining carbonaceous residue, which is used in making black varnish. It is soluble in alcohol.

## OBSERVATIONS.

There can be no doubt that this substance derives its origin from the vegetable kingdom, as it occurs particularly in beds of bituminous wood, and often includes insects and other organic remains. Sir David Brewster's experiments on its optical properties establish it beyond a doubt as an indurated vegetable juice. The traces of a regular structure, indicated by its action upon polarized light, he is of opinion, are not the effect of the ordinary laws of crystallization by which mellite has been formed, but are produced by the same causes which influence the mechanical condition of gum-arabic and other gums, which are known to be formed by the successive deposition and induration of vegetable fluids. The largest specimens of amber occur on the Prussian coast, where it is disengaged by the action of the waves and cast ashore; and whence, according to Phillips, it is also obtained by mining. A shaft has been put down on the sea-coast, which reaches a bed of bituminous coal, and from thence it is obtained in considerable abundance. It is also found on the whole line of the Baltic coast, Courland, Livonia, Pomerania, and Denmark; sometimes presenting very peculiar tinges of blue, on the Sicilian coast, near Catania; imbedded in brown coal, at Hasen Island in Greenland; in clay near Paris; and elsewhere. It is used in the fabrication of ornaments, and considerable value is attached to large transparent specimens. In the Royal Museum at Berlin there is a mass weighing eighteen pounds; and vast quantities are preserved in many of the German collections. Of those insects which have been originally inclosed in amber, some are plainly seen to have struggled hard for their liberty, and even to have left their limbs behind them in the attempt; it being no unusual thing to find in a mass of amber which contains a stout beetle, the animal wanting one or perhaps two of its legs, and those legs left in different places, nearer that part of the mass from which it set out. This also may account for the common accident of finding legs or wings of flies without the rest of their bodies in pieces of amber; the insects having, when entangled in the yet soft and viscid matter, escaped at the expense of leaving those limbs behind them. Many of these insects are unknown at the present day.

By distillation amber yields the succinic acid; and when dissolved in oil, forms a useful varnish. Its resino-electric properties were well known to the ancients, who termed it *electrum*; whence our word elec-

tricity. As amber has frequently much resemblance both to mellite and copal, it is well to remark that mellite does not fuse when exposed to heat as this does; and that a bit of copal heated at the end of a knife takes fire, and melts into drops which flatten as they fall; while amber burns with spirting and frothing; and when its liquefied particles drop, they rebound from the plane on which they fall.

Its chemical examination by Berzélius (*Ann. de Chimie*, tom. xxxviii.), confirms Sir D. Brewster's conclusions as to the vegetable origin of amber.

### BITUMEN.

Black Mineral Resin, *M.* and *J.* Mineral Oil, Petroleum, Naphtha, Bitumen, Mineral-Pitch, *P.* Erdol, Erdpech, *W.* Bergpech, Elaterit, Bergtheer, Naphtha, *Haus.* Asphalt, *L.* Bitume, *H.*

Sp. Gr. 0·8—1·2. H. = 0·0—2·0.

No regular form; solid, elastic, fluid, and in all the intermediate stages. *Colour* black, passing also into various brown and red tints. Fluid varieties sometimes perfectly colourless and transparent. When elastic, translucent on the edges, and presenting a brilliant dark orange-red colour; when solid, opaque, and nearly quite black. *Lustre* resinous. *Streak* commonly unchanged. *Fracture* of the solid varieties perfectly conchoidal, and very brilliant. Sectile. Odour bituminous. Naphtha consists of

Carbon 82·2 87·60

Hydrogen 14·8 Thomson. 12·78 Saussure.

It is easily inflammable, naphtha burning with a white flame and much smoke, and mineral pitch emitting a bituminous odour. It dissolves resins, but is not itself soluble either in alcohol or ether. Some varieties melt in a high temperature.

### OBSERVATIONS.

This species includes both *mineral oil* and *mineral pitch*, which, though to all appearance distinct substances, differ only in their state of aggregation. *Mineral pitch* or *asphaltum* has been divided into elastic, earthy, and slaggy. The first is distinguished by its elasticity, which it sometimes retains long after being taken from its original repositories, and, in consequence of its general resemblance to India rubber, has received the name of *mineral caoutchouc*. It possesses nearly the same specific gravity as water, and occurs in large masses at the Odin mine, near Castleton, in Derbyshire. Earthy mineral pitch is only distinguished from the slaggy variety by its having a less conchoidal fracture. It occurs, inclosing crystals of calc spar, at the coal mines of Hurlet near Paisley,



in East Lothian and other places; while slaggy mineral pitch, which is the most common variety, is found in large quantities mixed with sand, at the pitch lake of Trinidad; in reniform stalactitic masses at Matlock in Derbyshire, the specimens from which present beautiful conchoidal fractures; in granite, with quartz and fluor, at Poldice, in Cornwall; in cavities of calcedony and calc spar from Russia and other places. Like the elastic variety, it is often soft when found, but soon hardens. Bitumen was used by the Egyptians in embalming, and is still employed by the Albanians in smearing their vessels.

Petroleum is a fluid variety of bitumen, which oozes out of certain rocks of the coal formation, and becomes hard on exposure. Sometimes it forms on the surface of springs, and dries around their edges, as at St Catharine's Well, near Edinburgh. The remarkable substance termed *disodile* by Cordier, probably consists of bitumen with a little sulphur. It forms soft pliant laminae, of a greyish-brown colour, resembling coarse brown paper; emits a fetid odour when burnt; and occurs in the vicinity of Syracuse, in Sicily.

The fluid variety of this species, called *mineral oil* or *naphtha*, is usually limpid or yellowish, and is found in considerable quantities in Persia and in the Birman empire. At Rangoon there are upwards of 500 naphtha wells, which yield annually about 412,000 hhds., amounting in value to £.170,000 sterling. It is of essential use in the manufacture of varnish, and is preferred to oil in the formation of oil paint, from its property of drying with great rapidity. Like alcohol, it is employed for removing spots of grease from woollen and other stuffs, but it is difficult to destroy the disagreeable odour which it emits. The inhabitants of Badku, on the Caspian, have neither fuel nor lights, except what they derive from this substance; and both in Persia and the Birman empire it is used as a lotion in cutaneous eruptions, and as an embrocation in bruises and rheumatic affections.

### RETINITE.

Retinite, *J.* Retinasphalt, *P.*

Sp. Gr. 1.1—1.2. H. = 1.0—2.5.

Massive. Roundish masses. *Colour* light brown, sometimes green, yellow, red, or in striped delineations. Semi-transparent or opake. *Lustre* resinous. *Fracture* conchoidal. It consists of

Vegetable resin	55.0	91.0
Asphalt or bitumen	42.0	9.0
Earthy matter	3.0 Hatchett.	0.0 Bucholz.

It takes fire at the candle, burns with a bright flame, and emits a peculiar odour. It is partly soluble in alcohol, leaving behind an unctuous residue.

## OBSERVATIONS.

Though this species presents characters somewhat different from those of bitumen, it yet appears to be more nearly allied to that than to any other substance. The purer specimens frequently consist of alternating layers more or less transparent, which correspond to the external shape, and commonly include a cavity. That from Bovey Tracey in Devonshire, where it is found accompanying brown coal, has a dry earthy texture, while the variety from Wolchow in Moravia is hard and resinous.



## ORDER COAL.

### COMMON COAL.

Bituminous Mineral Coal, *M.* Brown Coal, Black Coal, *J.* Common Coal, Cannel Coal, Jet, *P.* Braunkohle, Schwarzkohle, *W. Hoff. Haus.* Pechkohle, Blatterkohle, Kannelkohle, Grobkohle, Russkohle, Bituminoses Holz, Moorkohle, Erdkohle, Papierkohle, *L.* Houille, Jayet, *H.*

Sp. Gr. 1.2—1.5. H. = 1.0—2.5.

No regular form or structure. *Colour* black or brown, passing when impure, into greyish tints. *Opake.* *Lustre* resinous, more or less distinct. *Streak* same as the colour, sometimes shining. *Fracture* either conchoidal or uneven. Frequently sectile. It consists of bitumen and carbon in various proportions, the best quality of Newcastle coal containing, according to Karsten, carbon 84.99, hydrogen 3.23, oxygen 11.78. The varieties are more or less easily inflammable, and burn with flame, at the same time frequently emitting a bituminous odour.

#### OBSERVATIONS.

This species comprises both the black and the brown coals of Werner, the varieties of which pass so much into one another that they are with difficulty distinguished. Under *black coal* is comprehended *cannel* or *parrot coal* as it is termed in Scotland, which occurs massive, without any visible composition; has a flat conchoidal fracture in every direction, and a dull resinous lustre; but it sometimes presents a naturally polished surface, and is then cut and turned into snuff-boxes and other ornaments. At Wigan, in Lancashire, it is found in considerable quantity, as also at Craigman in Ayrshire, and at Gilmerton near Edinburgh, where it occurs interstratified with common coal. The variety from Workington is not so compact in its structure, and has not the fine conchoidal fracture of the others. *Jet* much resembles cannel coal, but is blacker, presents a more brilliant lustre, and generally, in this country, occurs in detached pieces among clay, as on the coast near Whitby in Yorkshire, and at Ballard Point, Swannage, Dorsetshire. It exhibits a woody texture, both externally and internally, visible, however, only by transmitted light, and in specimens cut extremely thin; it then has a brown translucent appearance. It is frequently used in the manufacture of bracelets, clasps, crosses, and other mourning ornaments. *Pitch coal* is velvet black, inclining to brown,

has a brilliant lustre, and affords in every direction a large and perfect conchoidal fracture. That from Soderoe, one of the Faroe Isles, has quite a glassy appearance, and, what is remarkable, is crossed with delicate parallel lines drawn in the direction of the stratification. The variety from Disko Island, in Greenland, is more closely allied to cannel coal; and that from Skye is almost identical with Werner's Grobkohle. The most common British variety of the present species is the foliated coal; it has a more or less stratified appearance, seldom presents a conchoidal fracture, but is often beautifully iridescent. The Elgin coal, from Dunfermline, has frequently a fibrous texture; and that from Merthyr Tydvil, in Wales, presents a peculiar fracture of the same description; in this the fibrous fracture intersects the stratification at a certain angle, and when that occurs on both sides, the fracture of the coal takes place along a series of ridges, whose section resembles the teeth of a saw.

The Newcastle coal mines are said to employ 60,000 individuals. The principal coal mines of France are those of St Etienne, which employ about 1400 workmen. There are also many mines in some of the northern departments; but the richest ones are within the Belgian frontier. Those in the neighbourhood of Mons, Charleroi, and Liege are very important; they amount to 350, employ 20,000 workmen, and yield annually about twelve millions of quintals of excellent coal.

Germany, taken together, is not rich in coal mines. In Sweden there are none except at Höganäs, near Helsingborg in Scania, which are worked with some vigour. Norway, Denmark, and Russia, appear entirely destitute of coal. In Italy the Apennines contain some trifling mines. In Spain, coal deposits are known in Andalusia, Aragon, Estremadura, Catalonia, Castile, and the Asturias; but the beds are thin, and the workings of little importance. In Portugal there is only one coal mine mentioned, which is worked in the province of Beira. Much coal also is wrought in China and Japan; it exists in the island of Madagascar, in Africa, in New Holland, and abundantly in America.

The best characteristic of *brown coal* is the peculiar peat-like odour it emits when ignited. It occurs massive, has commonly some shade of brown, and frequently exhibits traces of ligneous structure. Sometimes, however, it possesses a perfect conchoidal fracture, with a resinous lustre, and in that case is blacker. It is found in vast quantities in Styria, and at the Meissner in Hessa; also in Sumatra, and at Hasen Island in Greenland, where it is interspersed with amber.

Brown coal likewise includes the following varieties:—*Bituminous wood*, which presents a ligneous texture, and is devoid of lustre and conchoidal fracture. This is found at Ballintoy in Ireland, at Bovey in Devonshire, in the Westerwald, at the Meissner in Hessa, and in Iceland, where it has received the name of *Surturbrand*. *Moor coal*, which is distinguished by its want of ligneous structure, and its property of splitting into angular fragments when first exposed to the air; it also is almost perfectly devoid of lustre and conchoidal fracture. It occurs in pro-



fusion in the north of Bohemia, at Carlsbad and Toplitz, and is found likewise near Corfe Castle in Dorsetshire. A species of brown silky fibrous coal, which, in consistency, resembles hemp or other vegetable matter, occurs among beds of brown coal near Frankfort on the Maine.

### ANTHRACITE.

Non-Bituminous Mineral Coal, *M.* Glance Coal, *J.* Mineral Carbon, Mineral Charcoal, Anthracite, Blind Coal, *P.* Stangenkohle, Glanzkohle, *W.* Anthrazit, *Haus,* Kohlenblende, *L.* Anthracite, *H.*

Sp. Gr. 1.3—1.6. H. = 2.0—2.5.

No regular form or structure. *Colour* iron-black, sometimes inclining to greyish-black. *Opake.* *Lustre* imperfect metallic. *Streak* unchanged. *Fracture* conchoidal. Like the diamond, it consists wholly of carbon, though in a very different state of aggregation, and occasionally mixed with small portions of iron, silica, and alumina. Being entirely free from bitumen, it is difficultly inflammable, but when it does yield to heat, it burns without flame, smoke, or bituminous odour, leaving a more or less considerable earthy residue. The anthracite from Kilkenny contains about 97 per cent. of carbon; that from Rhode Island about 94.

### OBSERVATIONS.

Glance coal has been divided into conchoidal and slaty, the latter of which is particularly designated *anthracite*. It occurs at Kongsberg in Norway, in the trap of the Calton Hill, Edinburgh, and at other places in Scotland, where it is known under the name of *blind coal*. Also at Kilkenny in Ireland, in several parts of Wales, where it is denominated *Welsh culm*; in Spain, Dauphiné, Savoy, &c. The district of the Lackawanna, and of Wyoming on the Susquehannah River in Pennsylvania, have of late years presented a most valuable field of this description of coal. Solid beds of from twelve to twenty and even twenty-five feet thickness present themselves throughout a region extending from sixty to seventy miles in length; and in some parts of it the excavations are of such an extent that “a coach and six might be driven into them, and turned again with ease.” The coal is wrought for culinary as well as for manufacturing purposes; one pit alone producing on an average 250 tons per diem. (Silliman’s Jour. xviii. 308.)

The neighbouring district of Mauch Chunk in Pennsylvania also affords most extensive strata of anthracite. One mine is described in Silliman’s Jour. xix. 12, as occupying an area of more than eight acres, and presenting a bed of fifty-four feet in thickness, which is worked to the open air, as in a stone quarry, and affords 340 tons of coal daily.

*Conchoidal glance coal* possesses a much more distinct conchoidal fracture, and has generally a more massive appearance, than the slaty variety. It is found at the Meissner in Hessa, and at Cumnock and Kilmarnock in Ayrshire. Besides glance coal, this species contains *columnar coal*, which, by Werner, is classed among the black coals. It is remarkable for its irregular columnar composition, and is principally found at the Meissner in Hessa, forming the upper part of a bed of brown coal, which is covered by basalt. At Craigman, also, and in some of the Newcastle pits, it occurs in contact with dykes of greenstone, at the former frequently passing into plumbago of a tolerable quality. Likewise at Rhode Island in the United States.

These varieties being more difficultly inflammable than bituminous coal, are principally used in lime-kilns, malt-kilns, iron founderies, and the like; but when once ignited in considerable quantity, they burn with a strong and durable heat; and indeed much of the difficulty of kindling may be avoided by the addition of some charcoal, and the judicious application of a current of air.

M. Brard made use of anthracite in preparing hatchets, scissars, and fine-edged tools; and mentions his conviction that it is only necessary to force a larger quantity of air into that fuel to procure the most excessive degrees of heat. See *Mineralogie appliquée aux Arts*, where a detailed account of the different purposes to which it may be applied will be found.

This species may be distinguished from the preceding by the difficulty with which it ignites, by the peculiar white light afforded by its flame, and by its not caking. Though easily frangible, it has generally also a slightly higher degree of hardness and specific gravity, and it never possesses the pure deep-black colour of coal. The numerous vegetable impressions which it presents, mark its origin pretty distinctly.

Closely allied to the present species is the *mineral charcoal*, which occurs in thin layers, and fibrous distinct concretions of a delicately silky black colour, in most of the coal fields of Great Britain; at Voitsberg in Styria; Disko Island, Greenland; and in other places.



## APPENDIX.

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### ÆSCHYNITE.

Æschenite, *Brooke*, Ann. of Phil. X: 188. Leonhard.

Sp. Gr. 5·14. H. = 5·0—6·0.

In oblique rhombic prisms, according to Brooke, of about 127°. *Colour* dark black, inclining to brownish yellow when translucent. *Lustre* resinous. *Fracture* imperfect small-conchoidal. Contains, according to Hartwall, titanic acid 56·0, zirconia 20·0, oxide of cerium 15·0, lime 3·8, oxide of iron 2·6, and oxide of tin 0·5. Before the blowpipe it yields in the matrass some water; on charcoal it swells and becomes yellow; with borax fuses readily into a dark-yellow glass; and with salt of phosphorus forms a transparent colourless bead.

This mineral occurs in the Ilmen range near Miask in Siberia, imbedded in felspar, and associated with mica and crystals of zircon.

### ALUMINITE.

Aluminite, *J. and P. Websterite*, *Levy*.

In reniform masses of a white or yellowish-white colour. *Opake*. Surface dull. *Streak* white, a little glimmering. *Fracture* earthy. Yields to the nail, adheres to the tongue, and is meagre to the touch. Contains, according to Stromeyer,

	Halle.	Newhaven.
Alumina	30·26	29·87
Sulphuric acid	23·36	23·27
Water	46·33	46·76

It fuses with difficulty, but dissolves readily in acids without effervescence. It imbibes water, but does not fall in pieces.

This mineral was first noticed by Mr Tennant on the sea-beach near Newhaven in Sussex, where it occurs in reniform masses and botryoidal concretions of a white colour, imbedded in ferruginous clay which rests upon the chalk strata. It is met with under similar circumstances at Epernay in France, and in plastic clay at Halle on the Saale in Prussia.

## ALUMOCALCITE.

Leonhard.

Sp. Gr. 2·174. Small fragments may be rubbed to powder between the fingers.

*Colour* milk-white, inclining to blue. *Streak* the same. *Fracture* conchoidal. Adheres strongly to the moistened lip. Yields water in the glass tube. Becomes opaque and grey coloured when exposed to heat in the platina forceps. With borax forms a colourless glass. In salt of phosphorus is soluble, with the exception of a silica skeleton. In concentrated muriatic acid it forms a transparent jelly. Kersten found it to consist of silica 86·60, lime 6·25, alumina 2·23, water 4·00.

This substance occurs in the clefts of iron-stone veins at Eybenstock in the Erzgebirge. Breithaupt separated it from opal, with which it had previously been confounded; and to him we are indebted for the above description.

## AMPHODELITE.

Nordenskiöld in Jahresbericht, 1833, p. 174.

Sp. Gr. 2·76. H. = 4·5.

Crystalline form resembling that of felspar. *Colour* light red; similar to scapolite in its fracture, and possessing two cleavages which meet at an angle of 94° 19'. Consists of silica 45·80, alumina 35·45, lime 10·15, magnesia 5·05, oxide of iron 1·70, water 1·85.

Occurs in the limestone quarry of Lojo in Finland.

## ANGLARITE.

Kobell, Mineralien.

In fibrous and compact masses. *Colour* grey, inclining to blue. Translucent. Contains, according to Berthier,

Phosphoric acid	28·82	27·3
Oxide of iron	56·67	56·0
Water	14·51	16·5

Before the blowpipe it melts into a black globule; and in the matrass yields water. It is readily and entirely soluble in water.

This is a phosphate of iron from Anglar, in the Haute-Vienne, France.

## ANTIMONPHYLLITE.

Breithaupt, Jahresbericht for 1832, p. 202.

Crystallized in thin unequiangular six-sided prisms. *Colour* greyish white. Contains oxide of antimony. Locality unknown.



## ARGENTIFEROUS SULPHURET OF COPPER.

Argentiferous Copper Glance, *J.* Sulphuret of Silver and Copper, *P.* Silber-kupferglanz of the Germans. Cuivre Sulfuré argentifère, *Levy*.

Sp. Gr. 6·25. H. = 3·0—4·0.

Massive. Composition impalpable. *Colour* steel-grey. *Lustre* metallic. *Streak* shining. *Fracture* slightly conchoidal. Perfectly sectile, and very brittle. Contains copper 30·48, silver 52·27, sulphur 15·78, iron 0·33—Stromeyer. Easily fusible. The blue solution which it forms in nitric acid presents indications of copper when a plate of iron is dipped into it, and in the same way precipitates silver upon a plate of copper.

It occurs associated with copper pyrites, calcareous spar, and hornstone, at Schlangenberg near Colivan in Siberia, and is very rare. At Combarvalla in Peru a variety of this species is met with, which contains a considerable proportion of iron. It was first described by Professors Hausmann and Stromeyer.

## ARSENICAL ANTIMONY.

Arsenik-Spiesglanz, *L.*

Sp. Gr. 6·2. H. = 2·0—4·0.

In kidney-shaped masses. *Colour* tin-white. Occasionally splendid, sometimes dull. Before the blowpipe it melts, and at same time emits considerable fumes of arsenic and antimony.

This species was noticed by Zippe at Przibram in Bohemia, where it occurs in metallic veins, associated with blende, antimony, sparry iron, &c.

## ARSENICAL BISMUTH.

Bismuth-Blende, *Breithaupt*, Poggendorff Ann. 1827, p. 275. Arsenik-Wismuth, *W.*

Sp. Gr. 5·9—6·1. H. = 3·5—4·5.

FIG. 10. In minute crystals presenting the rare form of the trigonal-dodecahedron, or in implanted globular masses. *Colour* dark hair brown or wax yellow. *Streak* yellowish grey. Semi-transparent or opaque. *Lustre* resinous or adamantine. *Fracture* uneven. *Cleavage* parallel to the faces of the dodecahedron, imperfect. Rather brittle. Contains carbonate of bismuth 58·8, arsenic acid 2·2, silica 23·8, arseniate of cobalt, copper, and iron 5·9, matrix 9·1—Hünefeld.

It decrepitates briskly before the blowpipe, emits an arsenical odour, and is ultimately converted into a glass, which effervesces with borax.

This species was described by Breithaupt, who noticed it accompanying cobalt ores and native bismuth, at Schneeberg in Saxony. Its general appearance is that of implanted globules, which rarely exceed the size of a pin head, and are of a dark-brown colour.

## BERZELINE.

*Necker de Saussure* in *Leonhard's Jahrbuch der Mineralogie*, II. 441.

A kind of anhydrous zeolite in extremely minute white crystals. Slightly translucent, and having a vitreous lustre on the fracture. It is difficultly fusible into a pale glass, and gelatinizes with heated acids.

From Galloro near La Ricia in the Roman States, where it accompanies crystals of black garnet and pinchbeck brown mica, in the drusy cavities of an augitic rock.

## BEUDANTITE.

*Levy*, *Ann. of Phil.* XI. 196.

H. = 4·0—4·5.

Occurs in small closely-aggregated crystals, being slightly obtuse rhombs (viz.  $92^{\circ} 30'$ ), with the summits truncated. *Colour* black. Translucent in thin fragments, and of a deep-brown colour by transmitted light. *Lustre* resinous. *Streak* greenish-grey. *Cleavage* easily effected perpendicular to the axis of the rhomb. The only substances Dr Wollaston could detect in it were oxide of lead and oxide of iron.

It is found at Horhausen, in the district of Nassau, on the Rhine.

## BISMUTH COBALT ORE.

Sp. Gr. 4·5—4·7.

Structure radiated. *Colour* intermediate between lead-grey and steel-grey. *Lustre* metallic, glistening or glimmering. *Streak* dull, same colour as the mineral. Consists of arsenic 77·96, cobalt 9·88, iron 4·77, bismuth 3·88, copper 1·30, nickel, 1·11, sulphur 1·01. Before the blowpipe it emits copious white fumes of arsenious acid, and deposits on the charcoal a yellow crust, the assay at same time assuming a brown colour. When well roasted, it communicates to borax a smalt-blue colour. If exposed in small pieces to low red heat in a glass tube, it yields a considerable quantity of arsenious acid.

This mineral was described by Kersten of Göttingen. It has been found only at Schneeberg in Saxony.

## BISMUTH OCHRE.

Oxide of Bismuth, *P.* Wismuthochre, *W.* Bismuth Oxydé, *H.* and *Levy*.

Sp. Gr. 4·36.

Occurs massive and disseminated. Crystalline form unknown. Friable, with an earthy aspect. *Colour* greenish- or greyish-yellow. Contains oxide of bismuth 86·3, oxide of iron 5·2, carbonic acid 4·1, water 3·4—Lampadius. It is easily reduced before the blowpipe, and is soluble in nitric acid.



Bismuth-ochre occurs pulverulent at Schneeberg in Saxony, at Joachimsthal in Bohemia, and with plumbo-cupriferous sulphuret of bismuth and native gold, at Beresof in Siberia.

### BISMUTHIC SILVER.

Bismuthic-silver, *J.* Bismuthic Silver Ore, *P.* Wismuthsilber *of the Germans.* Bismuth Sulfuré Plombo Argentifère, *Levy.*

Soft.

Rarely in acicular or capillary crystals; generally in amorphous masses. *Colour* tin-white or greyish, subject to tarnish. *Opake.* *Lustre* metallic. *Fracture* uneven. *Sectile.* Contains bismuth 27·0, lead 33·0, silver 15·0, iron 4·3, copper 0·9, sulphur 16·3—Klaproth. It is soluble in dilute nitric acid; and fuses readily before the blowpipe into a silver button, at same time covering the charcoal with an areola of the oxides of lead and bismuth.

This species occurs with copper-pyrites, in small amorphous masses at Schapbach in the valley of Kintzig in Baden. It is used as an ore of silver.

### BOLE.

Sp. Gr. 1·6—1·97. Soft, or very soft.

Massive. Composition impalpable. *Colour* brown, yellow, or red. Translucent on the edges, opake. *Fracture* perfect conchoidal. Dull or faintly glimmering. *Streak* shining, or resinous. Rather sectile. Adheres to the tongue. Feels greasy. When thrown into water it emits a crackling noise and falls into powder. Bole occurs in the Habichtswald in Hessia, at Striegau in Silesia, at Scheibenberg in Saxony, in Tuscany, and elsewhere, forming either irregular beds, or disseminated nodules, in wacke and trap-tuff.

### BREISLAKITE.

Occurs in delicate capillary crystals of a reddish-brown or chestnut-brown colour, bent and grouped like wool, coating the cavities of certain lavas. Its fibres are flexible; its lustre metallic.

It contains silica, alumina, iron, and a considerable proportion of copper, affording, when fused with salt of phosphorus, a green globule, which becomes red in the reducing flame. It accompanies nepheline pyroxene, and other Vesuvian minerals; and is met with both at that locality and at Capo di Bove near Rome.

## BUSTAMITE.

Silliman's Journal, XVIII. 392.

Sp. Gr. 3.1—3.3.

*Colour* grey, greenish, and reddish. Almost opaque. Consists of silica 48.90, oxide of manganese 36.06, lime 14.57, protoxide of iron 0.81.

It comes from Mexico, and will take its place near the silicate of manganese.

## CHAMOISITE.

Kobell, Mineralien, II. 246.

Sp. Gr. 3.0—3.4. Pretty hard.

Massive. *Colour* greenish-grey or black. *Fracture* granular or earthy. Magnetic. Contains silica 14.3, alumina, 7.8, oxide of iron 60.5, water 17.4—Berthier. Is soluble in acids, with the exception of its silica.

Occurs at Chamoisin in the Valais.

## CHELMSFORDITE.

Cleaveland.

Sp. Gr. 2.4.

In rectangular prisms, occasionally modified; also amorphous. Presents one imperfect cleavage. Contains 75 per cent. of silica.

It occurs in Chelmsford in the United States, associated with quartz, mica, and apatite.

## CHLOROPAL.

Schweigger's Jour. Chloropal, P.

Sp. Gr. 1.7—2.0. H. = 3.0—4.0.

Of this there are two varieties; the one massive and compact, the other earthy. *Colour* pistachio-green. Opaque, or feebly translucent on the edges. *Fracture* conchoidal and splintery. It does not phosphoresce. It consists, according to Brandes, of

	Conchoidal.	Earthy.
Silica	46.0	45.0
Oxide of iron	35.3	32.0
Magnesia	2.0	0.0
Alumina	1.0	0.7
Water	18.0	20.0
Manganese	a trace	2.0

It occurs associated with opal at Unghwar in Hungary, and appears to be closely allied to *green iron-earth*.



CHLOROPHÆITE.<sup>1</sup>

Chlorophæite, P. *Macculloch*, Western Isles, I. 504.

Sp. Gr. 2·02. Scratched by a quill.

Massive, in small grains or nodules from the size of a radish-seed to that of a pea; sometimes hollow. *Colour* pistachio-green, and transparent like olivine, but soon becoming brown and black, and turning opaque like steatite on exposure to the air. Brittle. *Fracture* conchoidal, or earthy. Before the blowpipe it scarcely undergoes any change, altering neither colour nor transparency. It consists principally of silica and iron, with a little alumina.

Dr Macculloch found this substance imbedded in basalt or amygdaloid at Scuirmore Cliff in the island of Rum, and in Fifeshire; and Mr Hutton of Newcastle has latterly noticed it in a basaltic dyke near the Coquet water in Northumberland. By some mineralogists it is considered a variety of serpentine, by others as decomposed olivine.

## COBALTIC GALENA.

Cobaltic Galena, or Cobaltic Lead Glance, J. *Cobaltbleierz*, *Haus*.

Sp. Gr. 8·44. Soft and sectile.

In minute moss-like groups of crystals, or massive. *Colour* lead grey, inclining to blue. Opaque. *Lustre* metallic and shining. The individuals are cleavable. Soils a little. Contains lead 62·89, arsenic 22·47, sulphur 0·47, iron 2·11, cobalt 0·94, arsenical pyrites 1·44—Du Menil. It splits into fragments before the blowpipe, and communicates a smalt-blue colour to glass of borax.

This ore used to be confounded with galena. It occurs in a vein of clay-slate and brown-spar, traversing grauwacke, in one of the Clausthal mines in the Hartz.

## CONITE.

Conite, *Friesleben*, J.

Sp. Gr. 3·0. Scratches glass.

Amorphous, massive, and in crusts. *Colour* flesh-red, externally coated with iron-ochre. Devoid of lustre. Opaque. Brittle. *Fracture* sometimes fine grained, or imperfectly conchoidal. Consists of carbonate of magnesia 67·5, carbonate of lime 28·0, oxide of iron 3·5, water 1·0.

It occurs in Iceland, on the Meissner in Hessa, and in Saxony. Dr Macculloch has given the same name to a pulverulent mineral, as fusible as glass, which he found in Mull, the trap rocks of Skye, Glenfarg, and Kilpatrick. This is an ill-described species, the accounts of different mineralogists being at variance.

## COPPER BLACK.

Kupferschwartz, *W.* Copper Black, *J.* Black Copper, *P.*

Disseminated in or investing other ores of copper, in shining botryoidal concretions or dull friable masses. *Colour* black or brownish black. Friable, and soils the fingers. Before the blowpipe *per se* it is infusible, but with borax yields a greenish slag.

Copper-black occurs in most of the Cornish mines, associated with copper pyrites, vitreous copper, and other ores of that metal, from the decomposition of some of which it is believed to result.

## COTUNNITE.

Cotunnia, *Monticelli*, Mineralogia Vesuviana. Cotunnite, *Kobell*, Mineralien, II. 179.

Sp. Gr. 1.897.

In acicular crystals. Is slightly scratched with the nail. *Colour* white. *Lustre* adamantine, inclining occasionally to silky or pearly. Contains muriatic acid 25.48, lead 74.52—Berzelius.

Fuses very easily before the blowpipe, colouring the flame blue, and emitting a white smoke, which is condensed on the charcoal. With soda globules of reduced lead are formed. In the matrass it fuses and is sublimated, and in about twenty-seven times its weight of cold water is entirely dissolved.

This substance was observed by Monticelli and Covelli, in the crater of Vesuvius, after the eruption of 1822. It was accompanied with muriate of soda, muriate and sulphate of copper, and other salts; and is named in honour of one of the medical men of Naples.

## COURZERANITE.

Ann. des Mines, IV. 327. Ann. of Phil. Aug. 1851.

Sp. Gr. 2.69. H. under 5.0.

According to Brooke, it resembles felspar in form, cleavage, and angular measurements. *Colour* varying from greyish-black to indigo-blue. Opaque; but when in fragments, transparent and brilliant. *Lustre* vitreous or resinous. *Fracture* slightly lamellar. Not acted upon by acids; but fusible at the blowpipe into a white enamel. Contains silica 52.37, alumina 24.02, lime 11.85, magnesia 1.40, potash 5.52, soda 3.96—Dufresnoy.

It was found by Charpentier, imbedded in limestone, in the steep defiles of Saleix in the Pyrenees, termed "des Couzerans."



CUMMINGTONITE.<sup>1</sup>

Thomson. Royal Society Trans. Edin. XI. 247.

Sp. Gr. 3.20. Easily scratched with a knife.

Occurs in fine needles, forming tufts of crystals, in which the individuals diverge slightly from one another. *Colour* greyish-white. *Lustre* silky. Opake, or translucent only on the edges. Alone it does not melt before the blowpipe; with soda it effervesces, and fuses into a dark-coloured globule; and with borax forms a black glass, indicating the presence of much iron and manganese. It contains silica 56.54, protoxide of iron 21.67, protoxide of manganese 7.80, soda 8.44, loss from heat 3.18—Thomson.

This mineral is found at Cummington, Massachusetts, in a rock composed of quartz and garnet. Leonhard unites it with epidote.

## CUPREOUS BISMUTH.

Cupreous Bismuth, or Cupriferous Sulphuretted Bismuth, *J.* Cupriferous Sulphuret of Bismuth, *P.* Kupferwismuthertz, *W.*

Soft and sectile.

Massive; composition columnar, impalpable. *Colour* pale lead-grey, passing into steel-grey and tin-white. Subject to tarnish. *Lustre* metallic. Opake. *Streak* black. *Fracture* uneven. Contains bismuth 47.24, copper 34.66, sulphur 12.58—Klaproth. It is partly soluble in nitric acid, the sulphur being left.

Cupreous bismuth has hitherto been noticed only in certain mines near Wittichen in Furstenberg. It is there associated with native bismuth and copper-pyrites, forming veins which traverse granite.

## DERMATINE.

Breithaupt. Jahresbericht for 1852, p. 202. Leonhard.

Sp. Gr. 2.136. H. about 2.0.

*Colour* dark olive-green or liver-brown. Low resinous lustre. Translucent on the edges. *Fracture* conchoidal. Feels greasy, and does not attach itself to the moist lip. *Streak* yellow, inclining to grey. Splits and becomes somewhat friable before the blowpipe, assuming at same time a darker hue.

From the serpentine quarry near Waldheim in Saxony.

## DYSCLASITE.

Connell.

Sp. Gr. 2.362. H. 4.0—5.0.

*Colour* white, with an opalescent tint, and considerable translucency. *Lustre* glistening and vitreous. Its texture is imperfectly fibrous; but

the fibres in some places diverge with considerable regularity, exhibiting an approach to crystalline structure. It is remarkably tough, and difficultly frangible, so as to require much time and labour to separate a mass into smaller fragments; from which property its name has been derived. It gives off water at a red heat, and before the blowpipe is *per se* fusible only on the edges, and without intumescence. With soda it yields with effervescence a semi-transparent glass; with borax and salt of phosphorus it presents colourless glasses; with nitrate of cobalt it shows no alumine re-action. When reduced to powder it gelatinizes readily with muriatic acid. Its constituents were found to be as follows: Silica 57·69, lime 26·33, water 14·71, soda 0·44, potash 0·23, oxide of iron 0·32, oxide of manganese 0·22—Connell.

This mineral was brought from Faroe by Count Vargas Bedemar of Copenhagen, who gave specimens of it to several persons in this country. It was supposed here to be a variety of mesotype, until distinguished, analysed, and described as above, by Mr Connell.

Sir David Brewster, who examined some of its optical properties, found that it possesses double refraction, and polarizes light in all directions, showing it to consist of a congeries of adhering crystals lying in all positions; and that it reflects a bluish light, and consequently transmits a yellowish one. He also found that it possesses no pyro-electricity.

### ERLAMITE.

Schweigger's Jour. der Chemie, VII. 76. Erlan, L.

Sp. Gr. 3·0—3·1. H. = 5·0.

Occurs massive, occasionally compact, generally in small and fine granular distinct concretions. *Colour* light greenish-grey. *Lustre* feebly shining, or dull. *Streak* shining, with a resinous lustre, and white. Structure distinctly crystalline, but no regular cleavage has been observed. *Fracture* in some specimens foliated, in others splintery.

Contains Silica	53·16
Alumina	14·03
Lime	14·39
Soda	2·61
Magnesia	5·42
Oxide of iron	7·14
Oxide of manganese	0·64—Gmelin.

Before the blowpipe it fuses readily into a slightly-coloured, transparent, compact globule; and in borax forms a clear greenish glass.

Erlamite is described as particularly resembling gehlenite in appearance. It was discovered by Breithaupt in the Saxon Erzgebirge, forming a part of the oldest gneiss formation. It appears to be a mere mechanical mixture.



## FLUELLITE.

*Levy.*

Prismatic. In small acute scalene four-sided pyramids (fig. 3) whose most acute solid angles are replaced. Angles of the pyramid  $109^\circ$ ,  $82^\circ$ ,  $144^\circ$ . White, and transparent. *Lustre* vitreous.

Occurs in minute crystals, with wavellite and uranite on quartz, at Stenna-gwyn in Cornwall. It was discovered by Levy, but examined and named by Wollaston, who found it to contain alumina and fluoric acid. It is an extremely rare mineral; according to Levy, a very few specimens only being known. One of these is in the British Museum, another in the cabinet of Mr Turner, and a third in that of Mr Heyer of Dresden, associated with wavellite.

This species is included by Haidinger in the order Haloide.

## FULLER'S EARTH.

Sp. Gr. 1.81—2.19. Very soft.

Massive. Composition impalpable. *Colour* grey, or white. *Streak* shining. Opaque or feebly translucent on the edges. Dull. *Fracture* uneven, or earthy; occasionally imperfect conchoidal. Sectile. Feels greasy. Scarcely adheres to the tongue. Falls to pieces when immersed in water, and forms a paste which is not plastic.

The peculiar property of this species is its absorbing oleaginous and greasy matter with facility. Hence its use in cleaning woollen cloth. It is supposed to be derived from the decomposition of certain rocks; and occurs in great quantities and very pure at Nutfield in Surrey, and in other counties in England. Also in Moravia, Styria, and Saxony.

## GIBBSITE.

Gibbsite. *Torrey* in New York Medical and Physical Jour. No. I. 68. Phil. Jour. VII. 388. Thonhydrat, *Kobell*.

Sp. Gr. 2.4. H. a little above 3.0, but easily reduced to powder.

In irregular stalactites or tuberoso masses. *Structure* indistinctly fibrous; the fibres radiating from the centre. *Colour* dirty greenish- or greyish-white. Slightly translucent. *Lustre* faint. Contains alumina 64.8, water 34.7—*Torrey*. It whitens, but is infusible before the blow-pipe; yields in the matrass much water, but does not effervesce with acids; and with solution of cobalt presents a fine blue.

This mineral was discovered in a neglected mine of brown hematitic iron, at Richmond in Massachusetts, in stalactites from one to three inches in length, and not less than an inch in diameter. It was analysed and described by Dr Torrey of New York, and named after Colonel Gibbs. It contains neither phosphoric nor fluoric acid; otherwise it bears considerable analogy to wavellite.

## GLAUCOLITE.

*Bergmann*, Edin. New Phil. Jour. III. 385.

Sp. Gr. 2·72—2·9. H. = 5·0.

Massive ; presenting traces of cleavage parallel to the faces of a rhombic prism of 143° 30' nearly (according to Brooke). *Colour* lavender-blue, occasionally passing into green. Translucent on the edges. *Fracture* splintery. *Lustre* vitreous. Contains, according to Bergmann,

Silica	50·58	54·58
Alumina	27·60	29·77
Lime	10·27	11·08
Magnesia	3·73	0·00
Potash	1·27	4·57
Soda	2·96	0·00

with a little iron and manganese, which, however, are not essential constituents. Before the blowpipe it whitens, and fuses on the edges ; but is soluble in borax or salt of phosphorus.

Menge noticed this mineral near Lake Baikal in Siberia, imbedded in compact felspar and granular limestone. It also occurs with elaeolite at Laurvig in Norway.

## GREEN IRON EARTH.

Grüne Eisenerde, *W.*

In reniform, botryoidal, and globular masses, presenting an impalpable composition. *Colour* siskin-green, passing into black and yellow. *Lustre* resinous ; the impalpable particles dull. *Streak* yellowish-grey. Brittle. It becomes brown and black before the blowpipe, but does not melt. Nor is it dissolved in nitric acid.

It has been found at Schneeberg in Saxony, and in the Hollerterzug in the county of Sayn.

## HATCHETINE.

Mountain Tallow. Mineral Adipocere, *Brande*. *Conybeare* in Ann. of Phil. N. S. I. 126.

Very light, and soft.

Occurs in flakes like spermaceti, or in granular masses resembling bees-wax. *Colour* yellowish-white, wax-yellow, or greenish-yellow. *Lustre* slightly glistening and pearly. Presenting considerable degrees of transparency when in flakes ; otherwise dull and opaque. Without odour or elasticity. It is soluble in ether, and melts at a temperature below the boiling point of water. Distilled over the spirit lamp it emits a bituminous odour, a greenish-yellow substance is disengaged, and a coaly residue remains in the retort.

Hatchetine is found filling small contemporaneous veins, lined with calcareous spar and rock crystals, in the iron-stone of Merthyr Tydvil in South Wales.



## HEDYPHAN.

*Breithaupt* in *Jahresbericht*, 1832, p. 201. *Leonhard*.

Sp. Gr. 5.404. H. = 3.0—4.0.

A white, shining, massive, extremely rare mineral, described by C. Retzius, from Langbanshyttan in Sweden. *Lustre* adamantine, inclining to greasy. It contains oxide of lead 52.95, muriatic acid 2.03, arsenic acid 22.78, phosphoric acid 6.20, lime 14.03—Kersten. Before the blowpipe it forms a white friable mass, but affords no arsenical odour.

This is evidently an arseniate of lead.

## HETEPOSITE.

*Ann. of Phil.* 1831. *Ann. de Chimie*, XXX. 294. *Kobell*, *Mineralien*.

Sp. Gr. when fresh 3.52; after exposure 3.39. H. about 6.0.

Massive. Structure lamellar. Colour greenish-grey or blue. *Lustre* resinous, like that of apatite. *Cleavage* in three directions, forming an oblique rhombic prism. After long exposure to the atmosphere, its colour becomes violet, and its lustre is changed into semi-metallic. Consists of

Phosphoric acid	41.77	48.0
Oxide of iron	34.89	35.5
Red oxide of manganese	17.57	16.5
Silica	0.20	0.0
Loss by heat	4.40—Dufrésnoy. 0.1—Vauquelin.	

It is soluble in acids, with the exception of its silica; and before the blowpipe fuses into a brown enamel, which has a semi-metallic lustre.

This species bears considerable analogy with the phosphate of iron and manganese, p. 64, though its composition is different. It occurs at Thoreaux in the Haute Vienne, and was noticed and described by M. Dufrésnoy.

## HURAUHITE.

*Ann. of Phil.* Jan. 1831. *Ann. de Chimie*, XXX. 302. *Kobell*, *Mineralien*.

Sp. Gr. 2.27. H. above 3.0.

In minute crystals of a reddish-yellow colour. Transparent. *Fracture* vitreous. *Cleavage* not observable. Consists of

Phosphoric acid	36.60	32.8
Oxide of iron	11.10	} 47.2
Oxide of manganese	32.85	
Water	15.00—Dufrésnoy.	20.0

It fuses readily before the blowpipe, affording a black button, which has a metallic lustre. Heated in the matrass it gives off water.

The above description of this new ore of manganese was given by M. Dufrésnoy, who named it from its locality, the Commune des Huréaux in the Haute Vienne.

## HYDROSILICITE.

*Kuh.* Edin. New Phil. Jour. III. 585.

Occurs with chrysoprase, opal, and pimelite, in serpentine, at Frankenberg in Silesia. It is massive, white, devoid of lustre, feels greasy, and is translucent; possesses an even fracture, is soft and amorphous, does not adhere to the tongue, and appears to consist almost entirely of pure silica and water.

## INDIANITE.

Indianite, *H. Bournon*, Phil. Trans. 1802, II. 233. *Leonhard*.

Sp. Gr. 2.74. Scratches glass.

In grains. Colour greenish-white. Translucent. Cleavage in two directions, forming an angle of  $95^{\circ} 15'$ . Consists of

Silica	42.5	43.0
Alumina	37.5	34.5
Lime	15.0	15.6
Oxide of iron	3.0	1.0
Soda	0.0	Chenevix 2.6 Laugier

with a trace of manganese. It does not fuse before the blowpipe; and when digested in acids, becomes friable and gelatinous.

This species is not well defined. It forms the matrix of the Indian corundum, and occurs principally in the Carnatic, associated with garnet, felspar, fibrolite, and hornblende.

## JOHANNITE.

*Haidinger*. Gesellschaft der Wissenschaften, Prag. 1830. Edin. Jour. of Science, N. S. III. 306

Sp. Gr. 3.19. H. = 2.0—2.5.

Hemi-prismatic. FIG. 172. Inclination of  $a$  to  $a' = 111^{\circ}$ , of  $a$  to  $b = 118^{\circ}$ , of  $a'$  to  $c = 87^{\circ} 28'$ , of  $b$  to  $c = 128^{\circ} 32'$ . In very minute crystals.

Colour deep grass-green. Translucent. Lustre vitreous. Streak pale siskin green. Taste slightly bitter. Cleavage traces parallel to  $a$ , and to a face which bevels the edge between  $b$  and  $c$ . Fracture imperfect conchoidal. It is partly soluble in water. Heated in the matrass it gives off much water, leaving a dark blackish-brown mass. Fused upon charcoal with soda, and then laid on a piece of silver and moistened, it blackens the metallic surface. In the reducing flame with soda, a bead of copper is obtained. With borax it forms a fine green glass, as well in the oxydating as in the reducing flame; in the latter it becomes red and opake on cooling, exhibiting the presence of oxide of copper. With salt of phosphorus only green colours are produced, that of the oxydating flame having more the appearance of copper, the reducing more of uranium. It therefore contains water, sulphuric acid, and the oxides of copper and uranium, but in what proportions has not been determined.



The sulphate of uranium occurs in extremely small crystals at Joachimsthal in Bohemia. It is a species as beautiful as it is rare, having only been observed in one mine, and that in the year 1809. It was discovered and described by Haidinger, who proposed the name of Johannite, in compliment to one of the most ardent and successful promoters of mineralogical science, his Imperial Highness the Archduke John of Austria.

### KARPHOSIDERITE.

*Breithaupt*, Brewster's Jour. VIII. 181.

Sp. Gr. = 2.5. H. = 4.0—4.5.

Occurs in reniform masses. *Colour* pale and high straw-yellow. *Lustre* resinous. *Streak* unchanged, glimmering. Feels greasy. Before the blowpipe it becomes black, and melts at a high temperature into a globule, which acts upon the magnet. It is easily soluble in borax, and with salt of phosphorus fuses into a black scoria. It contains oxide of iron, phosphoric acid, and water, with small quantities of manganese and zinc.

The karpnosiderite was distinguished by Breithaupt of Freyberg among some minerals from Greenland. It has much resemblance to oxalite or iron sinter, and derives its name from its peculiar straw-yellow colour.

### KEROLITE.

Cerolite. Kerolite, L. *Breithaupt*.

Sp. Gr. 2.0—2.2. H. about 2.0.

In kidney-shaped masses. Structure lamellar and compact. *Colour* white, green. *Lustre* vitreous or resinous. Transparent or translucent. *Fracture* conchoidal. Feels greasy, but does not adhere to the tongue. Contains silica 37.95, alumina 12.18, magnesia 16.02, water 31.00—Pfaff.

This species evidently comes under the order Terene. It is found at Frankenstein in Silesia, and at Zöblitz in Saxony, in both localities associated with serpentine.

### KNEBELITE.

Knebelite, P. and L.

Sp. Gr. 3.71. Hard.

Massive. Surface cellular and uneven. *Colour* grey, spotted dirty-white, red, brown, and green. Opake. *Lustre* glistening. *Fracture* imperfect conchoidal. Brittle. *Per se* it is not affected by the blowpipe, but with borax fuses readily into a dark olive-green pearl. Contains silica 32.5, protoxide of iron 32.0, protoxide of manganese 35.0—Döbereiner. No locality is given.

## KROKYDOLITE.

*Hausmann.*

Blue iron stone of Klaproth, from the Orange River in Southern Africa. Of this there are two varieties (one asbestos like, the other fibrous), named from *κροκος*, *like wool*, on account of their extraordinary divisibility into the minutest threads. Contains, according to Stromeyer,

	<i>Asbestos.</i>	<i>Fibrous.</i>
Silica	50·81	51·64
Protoxide of iron	33·88	34·38
Oxide of manganese	0·17	0·02
Magnesia	2·32	2·62
Soda	7·03	7·11
Water	5·58	4·01
Lime	0·02	0·05

It is said also to occur in the zircon-syenite of Stavenn in Norway, although that variety does not precisely resemble the African one. Its specific gravity is between 3·2 and 3·39. *Colour* lavender blue, blackish blue, or leek green.

The composition of this mineral bears a remarkable analogy with that of acmite.

## MARMOLITE.

*Nutall*, in *Silliman's Jour.* IV. 19. *Magnesie Hydratée Siliceuse*, *Levy. Thomson*, *Royal Soc. Trans. Edin.* XI. 271.

Sp. Gr. 2·41—2·47.

Easily scratched with the knife. Massive; having a columnar or foliated texture. *Colour* grey and green. Translucent or opaque. *Lustre* pearly. *Cleavage* in two directions, parallel to the sides of an oblique four-sided prism, one of them obtained with facility. Contains

Magnesia	46·0	41·72
Silica	36·0	41·26
Water	15·0	17·68
Lime	2·0	6·00
Alumina	0·0	1·00
Oxide of iron	0·5—Nutall.	0·40—Thomson.

It decrepitates and hardens before the blowpipe, separating into feathery-like masses, but does not fuse. With nitric acid it forms a gelatinous paste.

This mineral was first described and named by Mr Nutall. It occurs, associated with hydrate of magnesia, in serpentine veins, at Hoboken in New Jersey, and in the Bare Hills, near Baltimore, U. S.



## MOHSITE.

*Levy*, Ann. of Phil. March 1827. *Brewster's Jour.* VI. 332.

Scratches glass readily.

In twin crystals, presenting the aspect of small flat tables almost circular, with alternate re-entering and salient angles on their edges. *Colour* iron-black. Opake, with a perfect metallic lustre. Surface brilliant. *Fracture* conchoidal, and shining. *Cleavage* not visible. Does not affect the magnet. Brittle.

M. Levy commences his description of this mineral by stating that "M. Heuland has lately added to his collection a small group of quartz slightly chlorited, upon which are seen some crystals belonging, I believe, to a new species, which, at his suggestion, I propose to call Mohsite, in honour of Professor Mohs;" and he adds, that "from the appearance of the group of rock-crystals upon which this substance occurs, it seems there can be no doubt that the specimen comes from Dauphiny." This circumstance, added to the analogy of some of their external characters, might suggest the idea that Chrichtonite and Mohsite belong to the same species; but the former presents a cleavage perpendicular to the axis, and is not sufficiently hard to scratch glass; two characters which distinguish it from Mohsite.

## MOLYBDENA SILVER.

Molybdena Silver, *J.* Molybdic Silver, *P.* Molybdan-Silber, *W.*

Sp. Gr. 7·2—8·0. Soft.

Rhombohedral. *Colour* pale steel-grey. *Lustre* metallic. Electric when in thin laminæ, and not particularly sectile. *Streak* dark iron-black. *Cleavage* perfect parallel to the faces of a rhomb.

Klaproth's analysis of molybdena-silver evidently refers to another species. Before the blowpipe on charcoal it melts, on the first impression of the point of the flame, into small globules, which become of a yellow and somewhat tarnished colour. When powdered it is soluble in nitric acid, with the exception of a portion of sulphur.

## MONTICELLITE.

*Brooke*, Ann. of Phil. Oct. 1831.

H. = 5·0—9·0.

In small imbedded crystals, having the general aspect of quartz. *Colour* yellowish; sometimes nearly transparent and colourless.

Occurs at Vesuvius imbedded in a crystalline carbonate of lime, along with particles of black mica and minute crystals of pyroxene. Its name

was proposed by Brooke, in honour of the celebrated Neapolitan mineralogist Monticelli.

### NATIVE CARBONATE OF LIME AND SODA.

Ann. of Phil. May 1830.

Sp. Gr. 2·92. H. = 3·0—3·5.

Rhombohedral. Fragments perfectly transparent. *Lustre* vitreous, resembling that of aragonite. Structure laminated. *Cleavage* in three directions, forming a rhomb similar to that of calcareous spar. Possesses double refraction. Contains carbonate of lime 70·0, carbonate of soda 14·0, water 9·7, peroxide of iron 1·0, besides 5·0 of matrix. Before the blowpipe it decrepitates a little, becomes brown, and eventually is reduced to lime. It is entirely soluble, and with effervescence, in nitric acid.

This mineral was described by M. Barruel, who procured it of a dealer, without being able to ascertain its origin. It is a similar compound with Gaylussite, but differs materially in its proportions, and totally in most other respects.

### NEMALITE.

*Nutall.* Siliceous Hydrate of Magnesia, *Thomson* in Royal Soc. Trans. Edin. XI. 468.

Sp. Gr. 2·35. Scratched by the nail.

Composed of elastic fibres, easily separable, and bearing a striking resemblance to the fibres of amianthus. *Colour* white, with a slight shade of yellow. Opaque. Contains magnesia 51·72, silica 12·57, peroxide of iron 5·87, water 29·67—*Thomson*. Becomes brown on exposure to red heat, and gives off water. Is soluble without effervescence in nitric acid, with the exception of a little silica.

This mineral was discovered by Mr Nutall in serpentine veins at Hoboken in New Jersey.

### NONTRONITE.

Ann. de Chimie, tom. XXXVI. *Berthier*, Brewster's Journal, X. p. 150. *Leonhard*.

Easily scratched with the nail.

Consistence like that of clay. *Colour* pale straw or canary yellow, with a greenish tinge. Opaque. Unctuous to the touch, very tender, and exhaling an odour when breathed upon. Acquires a fine polish and resinous lustre under the friction of softer bodies. Is flattened, and grows lumpy under the pestle, instead of being reduced to powder, and does not act on the magnetic needle. Contains silica 44·0, peroxide of iron 29·0, alumina 3·6, magnesia 2·1, water 18·7, clay 1·2. When immersed in water it disengages many air-bubbles, becomes translucent at the edges, and



after immersion for some time, is found to have increased one-tenth in its weight. It loses its water when slightly heated, and assumes the colour of red oxide of iron. Is easily acted upon by muriatic acid, and the portion not entirely dissolved is gelatinous. When calcined it becomes sensibly magnetic.

It occurs in kidney- or bulbous-shaped masses, seldom exceeding the size of the fist, among manganese, in the arrondissement of Nontron in France. It was noticed by Professor Berthier, and is described by him in the *Ann. de Chimie*.

### OSMELITE.

Leonhard.

Sp. Gr. 2.79—2.83. H. = 4.0—5.0.

In thin prismatic concretions, scopiformly or stellularly arranged. *Colour* greyish-white inclining to smoke-grey. *Translucent*. *Lustre* not great, between pearly and vitreous. Feels greasy, and when breathed upon emits an argillaceous odour; hence its name from *οσμη*, *smell*. *Cleavage* in one direction. In the mouth it feels as if about to dissolve, although no change takes place.

Occurs superimposed on calcareous spar, mixed with datholite, in trachyte at Niederkirchen, near Wolfstein, on the Rhine. Described by Breithaupt.

### PEGANITE.

*Breithaupt, Jahresbericht, 1832, p. 202.*

A crystallized green mineral from the transition slate between Langenstriegis and Frankenberg in Saxony, where it occurs associated with wavellite. It is a phosphate of alumina containing water.

### PEKTOLITE.

*Kobell, Mineralien. Brewster's Jour. IX. 364.*

Sp. Gr. 2.69. H. = 4.0—5.0.

Occurs in spheroidal masses which have a columnar composition, and consist of delicate divergent individuals radiating from a centre. *Colour* greyish. Surface generally dull. *Opake*. *Lustre* pearly at the fracture. It contains silica 51.30, lime 33.77, soda 8.26, potash 1.57, water 33.89, alumina and oxide of iron 0.90—Kobell. It yields readily a white translucent glass when exposed to the action of the blowpipe.

It bears considerable resemblance to certain fibrous radiating varieties of mesotype. It forms large masses on Monte Baldo in Southern Tyrol, and at Monzoni in the Fassa-thal.

## PELOKONITE.

*Richter* in *Poggendorff Ann.* XXI. 590. L.

Sp. Gr. 2·5—2·57. Scratched by fluor.

Uncrystallized. *Colour* blackish-blue. *Streak* liver brown, with a low degree of lustre, and conchoidal fracture. Contains phosphoric acid, the oxides of iron and manganese, and some copper.

It occurs in Chili associated with malachite and chrysocolla, and derives its name from *πελος*, *brown*, and *κονις*, *powder*, in allusion to the colour of its streak, from which last property it may be distinguished from cupreous manganese.

## PIMELITE.

*Pimelite*, P. and *Levy*.

H. under 3·0.

Massive; earthy. *Colour* apple-green, occasionally inclining to yellow. Opaque, and devoid of lustre. Soft and greasy to the touch. *Fracture* earthy. Contains oxide of nickel 15·62, silica 35·00, alumina 5·10, water 37·91, magnesia 2·25, lime 0·40—*Klaproth*. It does not fuse before the blowpipe, but assumes a scoriaceous appearance on the edges, and becomes dark grey. With borax, however, it forms a violet-coloured globule, in which the nickel is reduced.

Occurs associated with chrysoprase at Kosemutz and Glassendorf in Silesia, and has much the aspect of decomposed opal.

## PLUMBO-CALCITE.

*Johnstone* in *Edin. Jour. of Science*, N. S. VI. 79.

*Form* same as the primitive rhomb of calcareous spar, or massive. Transparent or opaque. Consists of carbonate of lime 92·2, carbonate of lead 7·8. When heated the carbonic acid is driven off, and the specimen assumes a reddish colour. Before the blowpipe it yields with soda a white enamel, but no reduced lead appears. Occurs among the old workings at Wanlockhead in Dumfries-shire.

## POLYBASITE.

*Kobell*, *Mineralien*, II. 76.

Sp. Gr. 6·214. H.=2·0—3·0.

Rhombohedral. In tabular-shaped six-sided prisms; also massive. *Colour* iron-black. Opaque. *Lustre* metallic. *Streak* black. *Cleavage* not observable. *Fracture* uneven. Contains sulphur 17·04, antimony 5·09, arsenic 3·74, silver 64·29, copper 9·93, iron 0·06—H. Rose.

From Guarisamey in Mexico.



## POLYSPHARITE.

*Breithaupt, Jahresbericht, 1832, p. 202. Leonhard.*

Sp. Gr. 5·83—5·89.

In roundish masses, having internally a radiated structure. *Colour* brown or yellow. *Lustre* greasy. *Fracture* conchoidal. It scratches mica, but is scratched by fluor spar. Contains oxide of lead, phosphoric acid, and magnesia. From the mines of Freyberg in Saxony, accompanying blende, galena, quartz, and iron pyrites.

## POON AHLITE.

*Brooke, Ann. of Phil. August 1831.*

H. 5·0—5·5.

In slender rhombic prisms of 92° 20'.

This species at first sight much resembles needlestone, with which it also nearly corresponds in hardness. Its crystals, however, traverse the matrix instead of forming groups in the cavities, and have not been observed with natural terminations. It occurs along with the fine apophyllites from Poonah in Hindustan.

## PROTHEEITE.

*Ure, Dictionary.*

Heavy. Scratches glass.

In rectangular prisms, the faces being striated longitudinally. *Colour* olive-green or white. Nearly opaque in large specimens, translucent in smaller. *Lustre* vitreous, inclining to adamantine. Is infusible before the blowpipe, and becomes electric by friction.

Has lately been discovered in the Zillerthal in the Tyrol.

## PYNGUITE.

*Leonhard.*

Sp. Gr. 2·315. H. under 2·0.

Massive. *Colour* siskin- and oil-green; with a slightly resinous lustre; and conchoidal or uneven fracture. Feels greasy. Does not adhere to the tongue, and emits a feeble argillaceous odour when struck. *Streak* lighter than the mineral. Extremely soft, resembling new made soap. Contains silica 36·90, oxide of iron 35·60, alumina 1·80, magnesia 0·45, oxide of manganese 0·14, water 25·10—Kersten.

In the matrass it yields much water. Before the blowpipe *per se* it becomes black, but only fuses on the edges. With borax it melts easily, exhibiting the presence of iron ; as also with salt of phosphorus, in which a skeleton of silica remains.

Occurs in a vein of barytes at Wolkenstein in the Erzgebirge, and has been severally described by Breithaupt, Freisleben, and Beckmann.

### PYRARGYLLITE.

*Nordenskiöld, Jahresbericht, 1833, p. 174.*

Sp. Gr. 2.50. H. = 3.35.

Occurs massive. Assuming, though rarely, a form analogous to the four-sided prism with bevelled edges ; frequently traversed with minute chlorite particles. *Colour* partly black, and in that case shining like sor-dawalite ; partly bluish, and then devoid of lustre. Contains silica 43.93, alumina 28.93, oxide of iron 5.30, magnesia, with a little oxide of manganese, 2.9, potash 1.05, soda 1.85, water 15.47 ; and is entirely soluble in nitric acid.

It occurs in granite near Helsingfors in Finland ; and was named by Nordenskiöld in allusion to its property of emitting an argillaceous smell when heated.

### PYROPHYLLITE.

*Silliman's Jour. XVII. 392. Poggendorff's Ann. XV. 592.*

This mineral used to be considered a radiated talc, but its comportment before the blowpipe is peculiar. Heated *per se* it swells up into leaves (hence the name, from *πυρ*, fire, and *φυλλον*, a leaf), and increases to twenty times its original bulk, but does not fuse. Soda dissolves it with effervescence, and heated with a solution of cobalt it becomes blue. According to Hermann of Moscow it consists of water 5.62, silica 59.79, alumina 29.46, magnesia 4.00, oxide of iron 1.80, and some oxide of silver.

It is brought from the country between Pyschmink and Beresof in the Ural Mountains of Siberia.

### REUSSITE.

*Ure, Dictionary.*

In mealy efflorescences ; flat, six-sided prisms ; and acicular crystals. *Colour* white. Shining. *Fracture* conchoidal. Contains sulphate of soda 66.04, sulphate of magnesia 31.35, muriate of magnesia 2.19, sulphate of lime 0.42—Reuss.



It forms an efflorescence on the surface of the ground in the vicinity of Sedlitz and Seidschutz in Bohemia.

### SELENIURET OF LEAD.

*Selenblei of the Germans. Plomb Seleniuré, Levy.*

Sp. Gr. 8·2—8·8 Haidinger. 6·7—6·8 Silliman.

Crystalline, form unknown. Colour lead-grey, inclining to bluish. Lustre metallic. Cleavage indistinct. Fracture granular and shining.

Contains Lead	70·98	63·92
Selenium	28·11	31·42
Cobalt	0·83—Turner.	3·14—Rose.

Before the blowpipe it is readily decomposed, affording, besides the usual phenomena arising from the presence of lead, the odour of decayed horse-radish, a reddish-brown matter being at same time deposited on the charcoal. When heated by means of a spirit lamp, in a clear glass tube closed at one end, the selenium almost instantly sublimes, forming a red ring within the tube, at the open extremity of which, its peculiar odour is very perceptible; and on heating the tube to redness, the ore fuses, the red ring partially disappears, and a white crystalline deposit remains.

Externally this mineral bears considerable resemblance to fine granular galena, though its colour is evidently different, having a cast of blue like molybdena. It is a rare substance, occurring only in the massive state in a vein of hematite, near Harzgerode in the Hartz. In consequence of some of its ore containing a few particles of native gold, it was collected by the Anhalt government for the purpose of extracting the precious metal; and thus its value to collectors has become greatly enhanced.

At Harzgerode the following compounds have also been met with.

*Seleniuret of lead and copper*, which contains selenium 29·96, lead 59·67, copper 7·86, iron 0·77. Its specific gravity is 7·0; and it fuses with great facility before the blowpipe.

*Seleniuret of lead and cobalt*,—selenium 31·42, lead 63·92, cobalt 3·14, iron 0·45.

*Seleniuret of mercury*,—selenium 24·97, lead 55·84, mercury 16·94. Analysed by H. Rose.

*Seleniuret of silver*, selen-silber of the Germans, a compound, according to G. Rose, of seleniuret of silver 89·71, and seleniuret of lead 6·79—Leonhard.

## SODA-ALUM.

*Thomson*, Royal Soc. Trans. Edin. XI. 466.

Sp. Gr. 1·88. H. about 2·0.

In fibrous masses. *Colour* white. The outer fibres opaque from decomposition; internally transparent, and having a glossy or silky aspect. Resembling alum in taste, but more soluble in water. Contains sulphuric acid 38·5, alumina 12·0, soda 7·5, water 42·0, with a little silica, lime, iron, and manganese—*Thomson*.

Native soda-alum is described as the produce of St Juan in South America. It there occurs in irregular nodules resembling fibrous gypsum, imbedded in a kind of soft blue slate.

## SULPHURET OF ALUMINA.

*Boussingault*, Ann. de Chimie, XXX. 109. *Thomson*, Royal Soc. Trans. Edin. XI. 461.

Sp. Gr. 1·66. Very soft.

In crystalline masses and efflorescences. *Colour* white, occasionally tinged yellow when impure. Translucent. *Lustre* silky. Taste, and comportment before the blowpipe, similar to alum.

Contains Sulphuric acid	36·4	35·87
Alumina	16·0	14·64
Water	46·6	46·37
Peroxide of iron	0·4	0·50
Soda	0·0— <i>Boussingault</i> .	2·26— <i>Thomson</i> .

*Humboldt* observed this mineral in clay-slate at Araya near Cumana; also at Socono, and elsewhere in South America.

## SULPHURET OF NICKEL.

Native Nickel, *M.* and *J.* Capillary Pyrites, Schwefel-nickel, Haarkies of the Germans. Nickel Sulfuré, *Levy*.

H. about 3·0.

In delicate capillary crystals of a brass-yellow colour, inclining to bronze-yellow and steel-grey. *Lustre* metallic. Brittle. Opaque. Consists of

Nickel	64·76	65·35
Sulphur	35·24	34·26 <i>Arfwedson</i> ,

with traces of cobalt and arsenic.

It fuses before the blowpipe into a brittle metallic globule, and colours borax violet-blue. It forms a pale-green solution with nitric acid.

Sulphuret of nickel occurs in thin capillary individuals, filling the cavities, and dispersed among the crystals of other minerals, at Joachimsthal in Bohemia, Johanngeorgenstadt in Saxony, Andreasberg, Cornwall, and other places.



## SCARBROITE.

Vernon, Ann. of Phil. March 1829.

Sp. Gr. 1·48. Easily scratched with a knife.

Massive. Colour pure white. Devoid of lustre. Fracture conchoidal. Highly adhesive to moist surfaces, and polished by the nail. Breathed upon, it emits a strong earthy smell; and when immersed in water neither becomes translucent nor falls to pieces, but gains considerably in weight. Contains alumina 42·75, silica 7·90, water 48·55, peroxide of iron ·80—Vernon.

It occurs in a calcareous rock on the coast of Scarbro', between double laminæ, or septa of oxide of iron. It was noticed by the Rev. W. H. Vernon, and is arranged by Berzelius along with halloysite and allophane. (*Vide* order Terene.)

## SCHEERERITE.

Edin. Phil. Jour. XVII. p. 187.

A species of combustible mineral found by Captain Scheerer in a bed of brown coal near St Gallen in Switzerland. It exists in loosely aggregated, whitish, feebly shining, pearly, crystalline grains, and foliæ, which generally occur in nests. It is rather heavier than water; does not feel greasy, is very friable, and has no taste. It melts readily into a colourless liquid at a temperature of 112°, and in that state resembles a fatty oil, and penetrates paper in the same manner; the spots, however, thus produced disappear when the paper is heated. On cooling, the melted mineral crystallizes in four-sided acicular crystals. When exposed to fire, it inflames and burns completely away, with a feeble aromatic smell. Contains carbon 73·0, and hydrogen 24·0. (Hartmann, Brews. Jour. N. S. iv. 73.)

## SILICATE OF CERIUM.

Wollastonite. Notice of Sir Alex. Crichton's Sale, in Brewster's Jour. VI. 357.

Regular hexagonal prisms. Colour pale yellowish-brown. Cleavage parallel to the axis of the prism. Translucent.

Occurs with emerald in magnesian carbonate of lime at Santa Fé de Bogota in Peru. It was examined by Wollaston. Some fragments of it, associated with emerald, are preserved in the British Museum.

## SORDAWALITE.

Sp. Gr. 2·53—2·58. H. = 2·5—3·0.

Massive. Colour greyish or bluish-black. Opake. Lustre vitreous. No trace of cleavage. Brittle. Fracture conchoidal. Streak liver-brown.

According to Nordenskiöld, it contains silica 49·40, alumina 13·80, peroxide of iron 18·17, magnesia 10·67, phosphoric acid 2·68, water 4·38.

Before the blowpipe *per se* it fuses with difficulty into a blackish globule, and with borax forms a green glass. With a small quantity of soda it yields a blackish-green globule, and with a larger quantity a rough slaggy mass. It is partly soluble in muriatic acid, and becomes of a reddish colour on exposure to the atmosphere.

This mineral was discovered and analysed by Nordenskiöld, who found it near the town of Sordawala in Finland, forming thin layers in a primitive rock. It occurs also with magnetic pyrites at Bodenmais in Bavaria.

### TAUTOLITE.

*Breithaupt.* Brewster's Journal. Ann. of Phil. May 1828. *Leonhard.*

Sp. Gr. 3·865. H. = 6·5—7·0.

*Colour* velvet-black. *Opake.* *Lustre* vitreous. *Streak* grey. *Cleavage* only in traces, and interrupted. *Fracture* conchoidal, uneven. Very brittle. Before the blowpipe it melts into a black scoria, which is attracted by the magnet; and with borax forms a clear green glass. These and other re-actions show that the mineral consists of silica, protoxide of iron, magnesia, and alumina.

Tautolite seems to be related to chrysolite. It occurs in volcanic felspar at the Laachersee near Bonn, on the Rhine. It was distinguished and described by Breithaupt of Freyberg.

### TELLURIC SILVER.

Tellur-Silber.

Sp. Gr. 8·41—8·56.

Uncrystallized. In coarse-grained masses. *Colour* between steel-grey and lead-grey. *Lustre* metallic. Soft, and partially malleable. Contains silver 62·63, tellurium 37·37—Rose. From the silver mines of Savodinski in the Altai Mountains.

Rose observed dispersed in small particles through the above, a massive mineral, which presents a distinct crystalline structure. Its specific gravity is 8·159; its colour tin-white, like native antimony; its lustre is metallic; and it is reducible to powder. He found it to be a compound of tellurium and lead, and named it therefore *tellur-blei* or *telluric lead*.

### TEPHROITE.

Silliman's Jour. XVIII. 391. *Leonhard.*

Sp. Gr. 4·116. H. = 5·0—6·0.

Massive and compact. *Colour* ash-grey, tarnishing black. *Lustre* adamantine. *Streak* somewhat paler than the mineral. *Cleavage* perfect in



several directions ; two of them forming together a right angle. *Fracture* imperfect conchoidal, or uneven. Forms a black slag before the blowpipe.

Occurs with franklinite and red zinc at Sparta in the United States.

### THORITE.

[Berzelius, Ann. of Phil. Nov. 1829. Thorit, L. Brewster's Jour. N. S. I. 207.

Sp. Gr. 4·63—4·8. Not scratched by the knife.

Massive and compact. *Colour* black. *Streak* dark-brown. *Fracture* vitreous, like that of gadolinite. Contains of the new earth Berzelius denominates thorina 57·91, lime 2·58, oxide of iron 3·40, oxide of manganese 2·39, oxide of uranium 1·58, oxide of lead 0·80, silica 18·98, water 9·50, with minute portions of magnesia, potash, soda, and alumina—Berzelius. Before the blowpipe it gives off water, and becomes yellow, but does not fuse. In a glass tube it exhibits traces of fluoric acid ; with borax it forms a glass, coloured by iron, and with salt of phosphorus fuses, with the exception of its silica.

This species was discovered by M. Esmark in syenite, near Brevig in Norway ; and is described as above by Berzelius. It is represented as closely resembling the Swedish gadolinite in external appearance.

### TITANIFEROUS CERITE.

Laugier, Ann. de Chimie, XXVII. 313.

H. = to that of gadolinite.

*Colour* blackish-brown, with a vitreous conchoidal fracture. Contains oxide of cerium 36·0, oxide of iron 19·0, lime 8·0, alumina 6·0, water 11·0, oxide of manganese 1·8, silica 19·0, oxide of titanium 8·0. These quantities exceed 100 by 9·55 parts, an excess occasioned by the protoxide of cerium in the mineral becoming peroxide in the analysis. It swells up when heated, and is acted upon both by acids and alcalies.

It comes from the Coromandel coast.

### TORRELITE.

Renwick, in Ann. of Phil. Brewster's Journal, II. 181.

Scratches glass.

*Colour* dull vermilion-red. *Streak* rose-red. *Fracture* granular. Affects the magnet slightly. Consists of silica 32·60, peroxide of cerium 12·32, protoxide of iron 21·00, alumina 3·63, lime 24·08, water 3·50—Renwick. It is infusible *per se*, but forms with borax a glass which is green while hot, but which becomes colourless on cooling. It effervesces with acid.

It occurs in Sussex County, New Jersey.

## TRIPOLI.

Tripoli, *J.* and *P.* Tripel, *L.*

Sp. Gr. 1·85—2·2.

Massive; composition impalpable. *Colour* yellowish-grey. *Opake*. *Streak* white. *Fracture* earthy, occasionally conchoidal. Feels meagre and somewhat rough, but does not adhere to the tongue. It imbibes water, which softens it; and when burnt becomes white and hard. Before the blowpipe it is with difficulty and slowly soluble with borax. It contains

Silica	81·0	90·0
Alumina	1·5	7·0
Oxide of iron	8·0	3·0
Sulphuric acid	3·5	0·0
Water	5·0 Bucholz.	0·0 Haase.

Tripoli appears to be a mere mechanical mixture of clay and fine sand. It occurs near Prague in Bohemia; in diluvial beds at Amberg in Bavaria, and in many other places. It is used in polishing metallic surfaces, and occasionally in making forms for casting.

## TURNERITE.

Turnerite, *Levy*. Ann. of Phil. XVIII. 241.

H. above 4·0.

FIG. 173. Hemi-prismatic. In small brilliant crystals. *Colour* yellow or brown. Transparent and translucent. *Lustre* adamantine. *Streak* white or greyish. *Cleavage* parallel to both diagonals of the prism, one of them more perfect. Consists, according to Children, chiefly of alumina, lime, magnesia, and a little iron, and differs from sphene (of which it used to be considered a variety) in containing very little silica and no titanium.

Occurs in Dauphiné, associated with quartz, albite, felspar, Crichtonite, and anatase. It has been denominated *Pictite*; but is a very rare mineral.

## URAN-BLOOM.

Uran-bluthe, *Zippe*, in Brewster's Journal, V. 185.

Soft.

In crystalline flakes of a small size, devoid of distinct forms. *Colour* bright yellow, between lemon- and sulphur-yellow. *Opake*, with little lustre. When slightly heated before the blowpipe, its colour becomes orange-yellow. It is soluble with effervescence in acid, yielding a yellow solution, which affords a brown precipitate with prussiate of potash, thus demonstrating it to be a carbonate of uranium.



Professor Zippe of Prague distinguished this substance from uran-ochre, or the yellow oxide of uranium (p. 87), chiefly from its want of lustre and more brilliant colour. It occurs in silver veins at Joachimsthal in Bohemia, with uranium ore, uran-ochre, and pharmacolite; and apparently is derived from the decomposition of uranium ore, on which it most commonly forms a coating.

### VANADIATE OF LEAD.

*Wohler Jahresbericht*, 1832, p. 200. *Johnstone*, Brews. Jour. N. S. V. 167. *Vanadinsaures Blei*, *Leonhard*.

Sp. Gr. 6·99—7·23. Scratched by the knife.

Irregularly crystallized. *Colour* varying from straw-yellow to reddish-brown. *Opake*, and generally dull. The fractured surfaces present a resinous lustre. *Streak* white. *Fracture* conchoidal. Brittle. Before the blowpipe, in a pair of forceps, it fuses, and on cooling retains its yellow colour; if kept some time in fusion, however, it is changed into a steel-grey porous mass, which upon charcoal yields immediately globules of lead. *Per se* on charcoal it fuses readily, exhales the odour of arsenic, is reduced, and leaves, after heating in the inner flame, a steel-grey very fusible slag, which exhibits the re-actions of chromium. It forms green solutions with the sulphuric and muriatic acids; a beautiful yellow solution with nitric acid. The Mexican variety consists of chlorite of lead 25·33, vanadate of lead 74·00, hydrous oxide of iron 0·67—*Berzelius*.

This mineral was first noticed at Zimopan in Mexico by Del Rio, who found it contained oxide of lead 80·72, a little oxide of iron and arsenic acid, and 14·8 of an acid of a peculiar metal to which he applied the name of Erythronium, from the circumstance of the salt of this acid yielding a fine red colour in fire.

Latterly it has occurred in considerable quantity among some of the old workings at Wanlockhead, in Dumfriesshire, where at first, from the resemblance it bears to that species, it was taken for an arseniate of lead. It is there found in small globular masses sprinkled over calamine, or in thin coatings on the surface of that mineral. Isolated and perfect crystals are rare, but occasionally the larger globules exhibit traces of six-sided prisms.

### VAUQUELINITE.

Hemi-prismatic Olive Malachite, *Haid*. Chromate of Lead and Copper, *P. Vauquelin*, *L.*

Sp. Gr. 5·5—5·8. H. = 2·5—3·0.

Hemi-prismatic. Macled. FIG. 69. Inclination of P to P' on the opposite side = 134° 30', of P to h = 149°. In minute irregularly aggregated crystals of a dark-green or black colour. Faintly translucent,

with a fine olive tint ; or opake. External *lustre* adamantine, often faint. *Streak* siskin-green or brownish. *Fracture* uneven. Contains oxide of lead 60·87, oxide of copper 10·80, chromic acid 28·33—Berzelius. Before the blowpipe, on charcoal, it slightly intumesces, and fuses into a grey metallic-like globule, yielding at same time small beads of reduced lead. It is partly soluble in nitric acid.

Vauquelinite accompanies the chromate of lead from Beresof in Siberia, generally in mammillated or amorphous masses or thin crusts. It has also been met with at Pont Gibaud in the Puy de Dome ; and, it is said, in Brazil, along with the chromate of lead from that country. Levy quotes its specific gravity as high as 6·8—7·2, and its hardness above 4·0.

### WAGNERITE.

Hemi-prismatic Fluor-haloide, *Haid.* Wagnerit, *Fuchs.* Schweigger's Jour. III. 269. *Kobell,* Mineralien.

Sp. Gr. 3·11. H. = 5·0—5·5.

Hemi-prismatic. An oblique rhombic prism. *Colour* yellow of different shades, often inclining to grey. Translucent. *Streak* white. *Lustre* vitreous. Most of the planes of the prism are deeply striated. *Fracture* uneven and splintery, in a direction transverse to the prism. Contains phosphoric acid 41·71, fluoric acid 6·50, magnesia 46·66, oxide of iron 5·00, oxide of manganese 0·50—Fuchs.

Before the blowpipe *per se* it fuses with difficulty into a dark greenish-grey glass ; with borax and salt of phosphorus, however, it is readily and entirely dissolved. From its powder digested in nitric or sulphuric acid, fluoric acid fumes are given off.

Only a few specimens of this rare mineral are known. It occurs in the valley of Holgraben, near Werfen in Salzburg, in irregular veins of quartz, traversing clay slate. A large well-defined crystal belonging to Mr Heuland is described by Levy in the Ann. of Phil. Feb. 1827. This species is arranged by Haidinger under Haloide, though its hardness exceeds the limits of that order.

### WOLCHONSKOITE.

Leonhard.

Amorphous. *Colour* bluish-green, passing into grass-green. Opake. *Streak* bluish-green and shining. Feels resinous. Adheres slightly to the tongue. *Fracture* imperfect conchoidal. Consists of silica, alumina, water, and about seven per cent. oxide of chrome. In water it falls to pieces, but after being dried is not affected by moisture.

This species was discovered and named by Kammerer. It occurs in the Ochanskyan circle, in the Perm government of Siberia ; and is so extremely fragile that on the slightest blow or shake it falls to pieces.



## XANTHITE.

Thomson in Ann. of Lyceum New York, April 1828. Mather in Silliman's Jour. XVIII. 359. Edin. Jour. of Science, N. S. IV. 372.

Sp. Gr. 3.20. Readily crushed by the nail.

Consists of a congeries of small rounded grains easily separable from each other. *Colour* light greyish-yellow. Translucent or transparent. *Lustre* splendid or shining, inclining to resinous. *Cleavage* parallel to the sides of a doubly oblique prism, and forming angles of  $97^{\circ} 30'$ ,  $94^{\circ}$ , and  $107^{\circ} 30'$ . Contains silica 32.71, lime 36.31, alumina 12.28, peroxide of iron 12.00, protoxide of manganese 3.68, water 0.60—Thomson. It is fusible in small particles on a fine slip of platinum foil. When in fusion it intumescs, and forms a greenish translucent bead, which is slightly attractable by the magnet. With borax it produces a glass which is yellow when hot, but colourless when cold.

It occurs imbedded in calcareous spar at Amity, in Orange County, U. S. The rounded grains of which it is composed, seem, when examined by the microscope, to consist of imperfect crystals, having a foliated texture.

## YELLOW TELLURIUM.

Yellow Gold Glance, or Yellow Tellurium, *J.* Weiss Tellur, *L.* Tellur Silber, Weiss Sylvanerz, Gelberz of the Germans.

Sp. Gr. 10.678. Soft.

FIG. 174. Inclination of  $p$  to  $p$  over the apex =  $73^{\circ} 40'$ , of  $M$  to  $M$  contiguous =  $143^{\circ}$ . Generally in imbedded crystalline laminæ. *Colour* silver-white, much inclining to brass-yellow. Opake. *Lustre* metallic. Traces of cleavage. *Fracture* uneven. Rather brittle. Contains tellurium 44.75, gold 26.75, lead 19.50, silver 8.50, sulphur 0.50—Klaproth. It fuses before the blowpipe into a metallic globule, emitting a pungent odour; and is soluble in nitric acid, leaving a residue of gold.

This very rare species is met with at Nagyag in Transylvania, where it accompanies foliated tellurium and red manganese, in veins which traverse porphyry; also in the Altai Mountains of Siberia.

## YTTRO-CERITE.

Sp. Gr. 3.4—3.5. H. between 4.0 and 7.0.

In amorphous masses of a violet-blue or reddish-brown colour. Opake, with generally an earthy texture, and no distinct cleavage. *Lustre* glistening. Two analyses by Berzelius yielded

Lime	47.63	47.77
Fluoric acid	25.05	24.45
Yttria	9.11	14.66
Oxide of cerium	18.22	13.15

It does not fuse before the blowpipe, but loses its colour and becomes white; when gypsum is added, however, it forms a globule, which becomes white on cooling.

It has hitherto been found only at Finbo, near Fahlun in Sweden, imbedded in quartz, and accompanied by albite and pyrophysalite. Haidinger arranges yttro-cerite with the order Baryte; its properties, however, would require to be more amply investigated.

### ZURLITE.

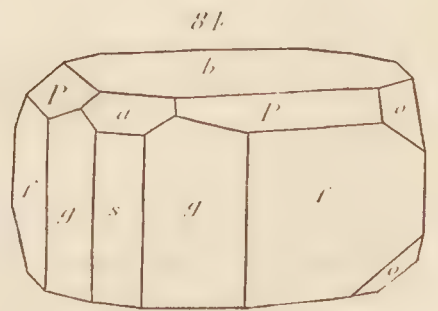
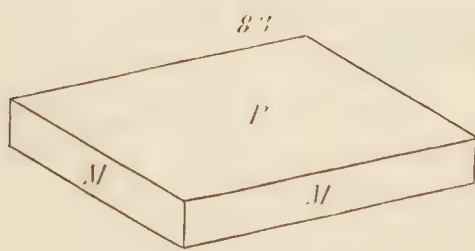
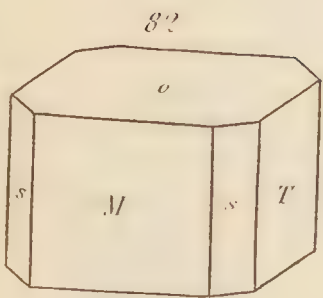
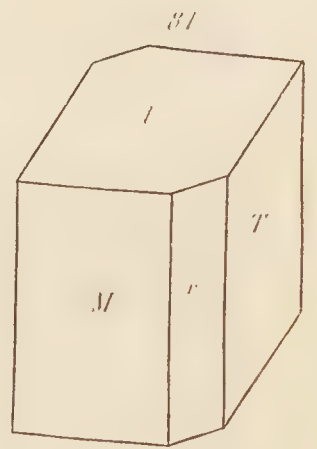
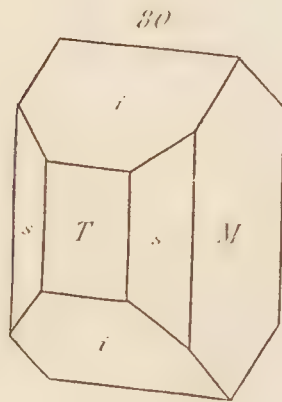
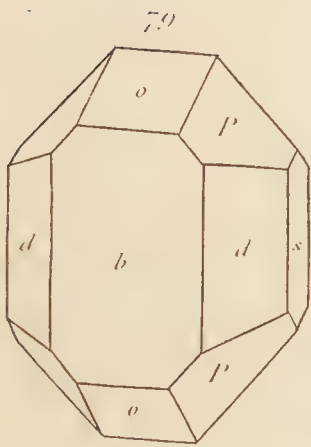
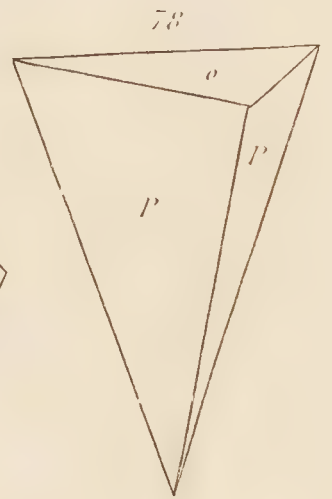
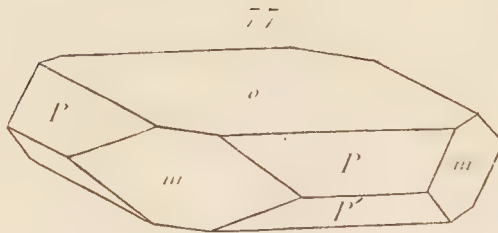
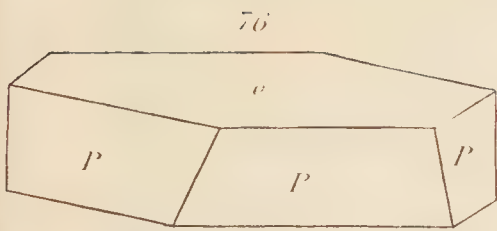
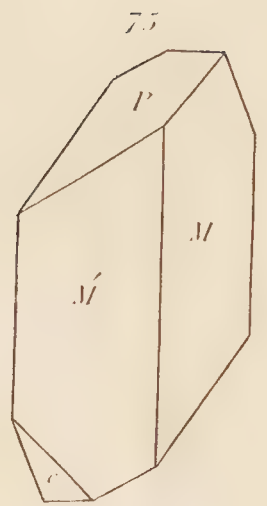
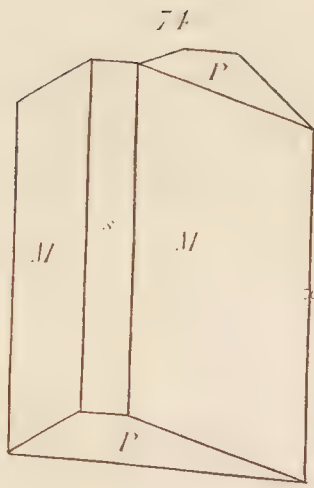
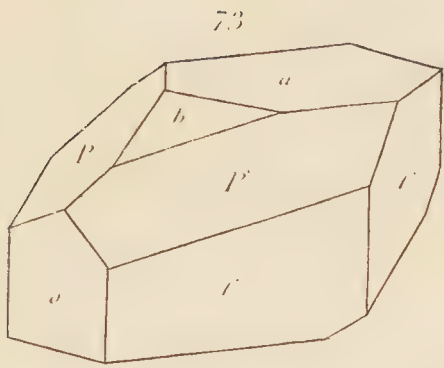
Zurlite, P. *Monticelli*, Mineralogia Vesuviana, 392.

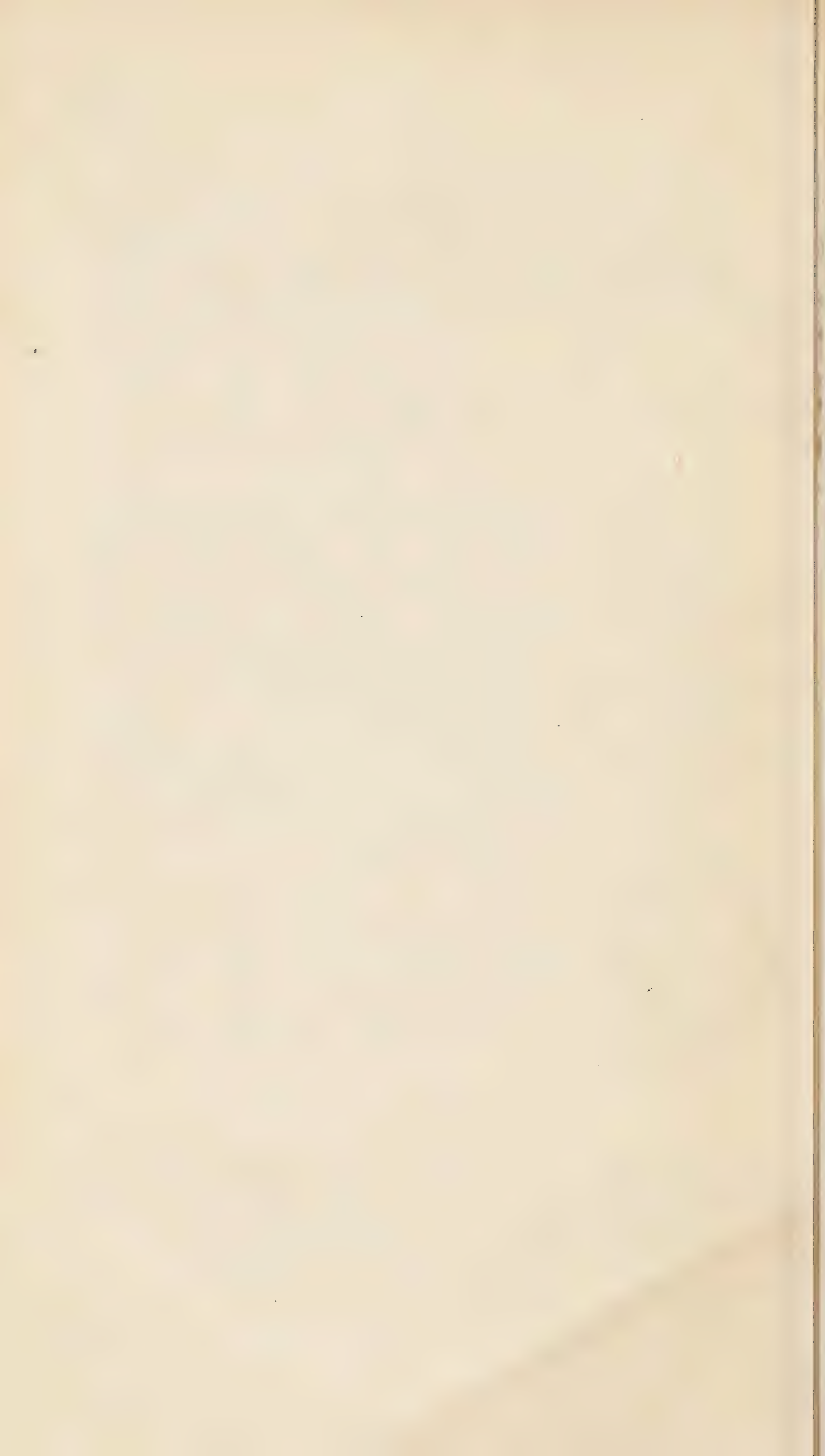
Sp. Gr. 3.27. H. about 6.0.

Occurs in rectangular four-sided prisms, lengthened in the direction of their axis, and having occasionally their lateral edges replaced. *Colour* asparagus-green, inclining to grey. *Opake*. *Lustre* resinous. *Cleavage* indistinct. *Fracture* conchoidal. Surface of the crystals rough, frequently covered with a white coating. It is infusible before the blowpipe, but yields with borax a black glass. Nitric acid dissolves it, partly with effervescence, and the solution becomes yellow.

Zurlite was discovered by Ramondini in 1810, and is described by him as above, in the Memoirs of the Academy of Naples. Monticelli copies his description in the Mineralogia Vesuviana. Its only locality is Vesuvius, where it is associated with calc spar and numerous other minerals, and generally occurs in large distinct crystals. Its name was proposed in compliment to the Neapolitan minister Sig. Zurlo.









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